

DESCRIPTIONS OF NEW SPECIES OF STARFISHES AND
OPHIURANS, WITH A REVISION OF CERTAIN SPECIES
FORMERLY DESCRIBED; MOSTLY FROM THE COLLEC-
TIONS MADE BY THE UNITED STATES COMMISSION OF
FISH AND FISHERIES.

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IN THE following list the serial arrangement adopted by Sladen in the Voyage of the Challenger has been followed pretty closely, partly as a matter of convenience, but also because it probably represents, in most cases, the real affinities of the genera more nearly than any other published classification. I am not prepared, however, to adopt all the families and subfamilies proposed by him.

ASTERIOIDEA.

Family ARCHASTERIDÆ, (Viguier, 1878) emended, Sladen.

BENTHOPECTININÆ, new subfamily.

Disk small; rays elongated, angular. Marginal plates large, spiniferous; an odd one, above and below, in the interradial angles. Dorsal surface covered with simple flattened plates usually bearing few spines; no paxillæ. Papulæ simple, arranged on the baso-median part of the rays and on the adjacent parts of the disk. Adambulacral plates, with a salient inner angle bearing spines. Pectinate pedicellariæ are sometimes present. No superambulacral plates. Dorsal pore very evident.

BENTHOPECTEN SPINOSUS, Verrill.

Benthopecten spinosus, VERRILL, American Journal of Science, xxviii, p. 218, 1884.

Pararchaster semisquamatus, var. *occidentalis*, SLADEN, Voyage of the Challenger, xxx, p. 10, 1889.

Pararchaster armatus, SLADEN, *op. cit.*, p. 19, pl. 1, figs 5, 6; pl. 4, figs 5, 6, 1889.

A comparison of a large series of this species, of various sizes from those that are 15 mm. up to large ones 260 mm. in diameter, shows that

the two forms described by Sladen from off the American coast are probably both identical with that described by me.

This species varies considerably in several details of its structure, according to its age. None of Sladen's specimens were full grown (largest size given is 74 mm. in diameter). Moreover there is often considerable variation in specimens of the same size and from the same locality, in the size of the disk, number, size, and arrangement of the spires on the marginal plates, etc. Some few examples have the disk at least one-third broader than others having the same length of rays, and such specimens naturally have large inferior interradial areas, with the plates more numerous than usual, as many as twenty to twenty-five being present in some cases. The papulae often extend out on the rays, in large examples, as far as the fifth pair of marginal plates; they cease sooner in the median line than to either side of it. They are often present on the central area of the disk, among the large primary spines. The actinal and adambulacral spines on the largest specimens are more numerous and longer than Sladen's descriptions indicate, but the half-grown specimens agree well with his examples, in most respects.

The pectinate pedicellariae described by Sladen as characteristic of *P. armatus* are commonly lacking entirely on our specimens, or exist only in very small numbers. The dorsal plates of the rays are rounded and ovate, unequal, and most commonly isolated in the integument. They usually bear only a single, small, slender, acute spine, rarely two. The large disk-spines are variable in number and length, but they are always restricted to the central area of the disk, and the largest are borne on the primary plates. The large single spines on the odd interradial marginal plates are usually long, tapered, acute, and distinctly larger and longer than those on the disk. The lower marginal plates generally bear, in large specimens, one large, primary, acute spine, and one or two, rarely three, secondary ones below it, besides several small, slender, divergent, rough spinelets scattered around their bases. The adambulacral plates, in such specimens, generally have two or three long, slender, rough spines on the actinal side, besides several small, slender, spinelets on the outer margin; the angular and salient inner margin usually bears about seven slender spines in a V-shaped group.

I have seen a few regular four-rayed specimens, and also one peculiar monstrosity, in which a small supplementary ray buds out from the side of the regular ray, near the base. This species occurred at many stations in 721 to 2021 fathoms.

PONTASTERINÆ, new subfamily.

Rays long; disk of moderate size. Papulae arranged in a group at the base of each ray, and sometimes on the disk. Dorsal surface covered with spinopaxillae and protopaxillae. Marginal plates all paired, usually spiniferous. Pedicellariae often present, mostly compound, two

to four-valved, or pectinate. Superambulacral plates are lacking. Fascioles rudimentary or lacking.

PONTASTER HEBITUS, Sladen.

Pontaster hebitus, SLADEN, Voyage of the Challenger, xxx, p. 33, pl. 8, figs. 1, 2; pl. 12, figs. 1, 2, 1889.

Archaster tenuispinus, VERRILL, Proc. U. S. Nat. Mus., II, p. 203, 1879; Rep. Com'r of Fish and Fisheries, XI [for 1883], p. 543, pl. 13, fig. 38, 1885 (probably not of Düben and Koren).

In my former papers I considered this species identical with *P. tenuispinus* of northern Europe, but Mr. Sladen describes it as distinct. The two forms are certainly very closely related, but, as I have not had the European species for comparison, I follow his decision.

Our specimens, however, in many cases, approach nearer to the European form than does the type of *P. hebitus*, as described by Sladen; for in our series the marginal and adambulacral spines are often mostly long and acute (not truncate as described) and the disk is often as large as in *P. tenuispinus*. But the pedicellariæ, characteristic of the latter, seem to be absent in the American form.

Most of the specimens have been taken by the Gloucester, Mass., fishermen from the fishing banks off Nova Scotia and Newfoundland, in 128 to 250 fathoms.

PONTASTER FORCIPATUS, Sladen.

Pontaster forcipatus, SLADEN, Voyage of the Challenger, xxx, p. 43, pl. 8, figs. 3, 4; pl. 12, figs. 3, 4, 1889.

Archaster tenuispinus, VERRILL (part), *op. cit.*, XI, p. 543, 1885 (not Dub. and Koren).

This species was also included by me, in some of my former articles, under the name of *Archaster tenuispinus*, of which it was at first supposed to be a variety.

It is easily distinguished from *P. hebitus* by the presence of only a single large spine on the actinal surface of the adambulacral plates. The peculiar four-valved to six-valved pedicellariæ are usually present in considerable numbers on the ventral surfaces; sometimes, on the distal part of the ray, pedicelled, three-valved ones occur. The central spine of the dorsal plates is larger and longer than in *P. hebitus*, and so are the marginal spines of both series. The papular areas are smaller, more rounded, and have but few pores. This species was taken at many stations, in depths ranging from 956 to 1,396 fathoms.

PONTASTER SEPTUS, Verrill.

Archaster septus, VERRILL, Amer. Journ. Science, xxix, p. 151, Feb., 1885.

This species is a true *Pontaster*. It is very distinct from both the preceding, and is easily distinguished by the relatively larger, broader, thicker, and more convex marginal plates, with deeper sutures between them. The marginal spines are more conical, with enlarged bases, but not so long as in the last species. The dorsal spinopaxillæ and para-

paxillæ are larger than in either of our other species; many have a slender central spine. The papular areas are small, rounded, and have few large pores. The genital openings are far apart, about opposite the distal third of the first pair of marginal plates and close to them. The upper marginal plates of the first pair are rounded and smaller than those that follow them, but the corresponding lower ones are distinctly larger and more swollen on the under side than those that succeed them. There is only one large stout spine on the actinal side of the adambulacral plates.

This occurred in 368 to 858 fathoms.

Subfamily PLUTONASTERINÆ, Sladen.

DYTASTER GRANDIS, Verrill.

Archaster grandis, VERRILL, Amer. Journ. Science, XXVIII, p. 218, 1884.

Dytaster madreporifer, SLADEN, *op. cit.*, p. 70, pl. 3, figs. 3, 4; pl. 32, figs. 5, 6, 1889.

This species is clearly identical with that so well described and figured by Sladen, but his specimens were not full grown.

Our large series includes all sizes from the young 10 mm. in diameter up to large ones 260 mm. in diameter. The very young specimens are widely different from the adults, but specimens 50 mm. in diameter have the general characters of the adults.

This species, and probably others of the genus, have well-developed superambulacral plates, which would, perhaps, indicate special affinities with the *Astropectinidæ* were not such plates present in several other widely different genera.

A few regular four-rayed examples have been taken. This species was taken in 384 to 2,620 fathoms.

PLUTONASTER AGASSIZII, Verrill.

Archaster agassizii, VERRILL, Amer. Journ. Science, XX, p. 403, 1880.

Plutonaster rigidus, SLADEN, *op. cit.*, p. 91, pl. 14, figs. 3, 4; pl. 15, figs. 3, 4, 1889; also var. *semiarmata*, *op. cit.*, p. 94.

Plutonaster bifrons (part), SLADEN, *op. cit.*, p. 88, 1889 (very young example).

This species is closely allied to *P. bifrons* of Europe and *P. intermedius* (Perrier sp.)* of the West Indian region. It varies greatly in respect to the armature of the marginal plates. In one large series there are among the adult specimens all gradations from those having no marginal spines whatever to those that have a large spine on nearly every marginal plate of both series. Therefore it is useless to recognize varieties based on this character, like the variety *semiarmata* of Sladen.

*Nouvelles Archives du Museum d'Hist. Nat., Ser. 2, vol. 6, p. 251, pl. VII, figs. 1, 2; pl. IV, fig. 4, 1884.

This species has distinct though short superambulacral plates at the base of the rays and within the margin of the disk, but they are lacking in the distal part of the rays. The papulæ are confined to a star-shaped area, occupying the center of the disk and the basal median part of the rays.

A few regular six-rayed specimens were taken by the *Albatross*.

The young, when very small, differ greatly from the adults in structure and appearance.

This is one of the most abundant of the deep-sea starfishes taken by the U. S. Fish Commission, as well as one of the most beautiful.

It occurred at many stations in 182 to 1,594 fathoms.

This and the other species of *Plutonaster* would be included in the genus *Goniopecten*, as defined by Perrier, but as his first species (*G. demonstrans*) appears to be a distinct generic type, perhaps allied more nearly to *Psilaster*, and apparently belonging to the *Astropectinidæ*, his name should be restricted to that type.

Subfamily PSEUDARCHASTERINÆ, Sladen.

PSEUDARCHASTER INTERMEDIUS, Sladen.

Pseudarchaster intermedius, SLADEN, Voyage of the Challenger, XXX, p. 115, pl. 19, figs. 3, 4; pl. 42, figs. 5, 6, 1889.

Archaster parelii, VERRILL, Amer. Journ. Science, VII, p. 500, 1874 (not Düben and Koren); XXIII, p. 140, 1882; Rep. U. S. Com'r Fish and Fisheries, XI, p. 543, pl. 13, fig. 37, 1885 (var. with narrow rays).

According to Sladen, this is distinct from the allied European *parelii*, with which I formerly identified it, but without a direct comparison of specimens.

Our numerous specimens show considerable variation, especially in the size of the marginal plates as compared with the breadth of the dorsal area of the rays. In some examples the upper marginal plates are so broad that the dorsal area is much reduced in breadth. In others the marginal plates are comparatively narrow, while the dorsal area is wider.

These differences are not correlated with any others of importance, so that they can hardly be taken as characteristic of permanent varieties.

The papulæ are confined to the central part of the disk and basomedian part of the rays.

Distinct fascioles are present in our specimens between the plates next to the adambulacral series, as in *P. discus*, but Sladen states that they are wanting in his examples. Moreover, in all our specimens there is a median row of several enlarged spinules decidedly larger than the rest, on each of the inferior marginal plates, which was not the case in Sladen's specimens. Similar enlarged spinules occur on most of the actinal interradial plates. In consequence of these differences our examples approach much nearer to *P. discus* Sladen, from the west coast

of S. America, and to *P. tessellatus*, from off Cape of Good Hope, than is indicated by Sladen's descriptions.

It ranges from 110 to 1,608 fathoms, off our coast.

PSEUDARCHASTER CONCINNUS, new species.

A large, regularly stellate, five-rayed species, having a broad flat disk and a rather thick margin with the interradial border regularly incurved. Rays broad at the base tapering regularly to slender sub-acute tips. Lesser to greater radius as 1 to 3.5.

Abactinal area covered with regular hexagonal and rounded paxilliform groups, those in the center of the disk and along the middle of the rays, decidedly larger than the rest, slightly convex, with a central group of from 20 to 30 obtuse, slightly elevated granules or papillae and a marginal series of from 20 to 30 smaller and more slender divergent papillae.

Upper marginal plates are nearly vertical and slightly convex and encroach but little on the disk. They are much higher than long on the margin of the disk, and are covered with rather large, rounded granules. Lower marginal plates nearly horizontal, confined largely to the actinal surface, and thickly covered with acute, imbricated spines, those on the middle largest.

Actinal interradial areas large, occupied by closely united plates, of which the outlines are indistinct. Each plate bears one to three or more acute fusiform spines in the middle, and a marginal series of much smaller and more slender spines of similar form or more clavate. The adambulacral plates project inward nearly half across the furrow, leaving deep angular notches between them. The furrow series of adambulacral spines arise from the margins of the projecting portion of the plate, and each angular group contains eight to ten rather slender, moderately long, obtuse spines, of which the middle ones are a little the longest.

The largest specimen, from station 2706, had, when dried, the radius of the disk, 34 mm.; of the rays, 105 to 110 mm.; breadth of rays at base, 40 mm.; height or thickness of interradial margin, 12 mm.; height of largest superior, marginal, interradial plates, 11 mm.; their length, 2.5 to 3 mm.; diameter of the large paxillae of the median radial series, 3 mm.; diameter of madreporic plate, 2 mm.

The central area of the disk is occupied by rather close set, roundish parapaxillae. The anal pore is small but distinct, nearly central. The madreporic plate is small, nearer to the center than the margin (distance from the center, 12 mm. in the largest specimen). The ten radial and interradial primary plates scarcely differ in size and form from the adjacent plates. Three to five rows of large hexagonal paxillae extend along the middle radial areas of the disk and bases of the arms, becoming smaller and less regular beyond the middle of the arm. On the disk these are bordered on each side by several rows of

similar paxilliform groups, which become smaller as they approach the interradiial margin; owing to this arrangement the largest and most regular paxillæ form a star-shaped area, in which the papulæ are situated. The larger hexagonal paxillæ often bear 50 to 60 granules and papillæ; nearly the whole of the round and slightly convex summit is occupied by the central group of somewhat elevated, blunt granules, which are not closely crowded; the extreme margin is bordered by about the same number of smaller, longer, and more slender papillæ, which spread outward, so that those of adjacent paxillæ are nearly or quite in contact, except at the angles, where the papulæ are situated. These paxilliform groups are borne upon round, convex, columnar or somewhat clavate elevations of the plates. In the triangular interradiial areas and along each side of the rays the plates are smaller and closely united, without papulary pores, and their central elevations become smaller and lower as they approach the margin, those near the marginal plate becoming oblong or elliptical and closely crowded together side by side in rows perpendicular to the marginal plates; usually two of these rows start inward from each marginal plate along the sides of the arms, but toward the center of the interradiial area three rows often correspond to a single plate. Similar plates occupy the entire breadth of the dorsal area of the arms beyond the middle, where no papulary pores exist, but those of the median row can be distinguished even to the tip of the arm by their larger size and broader form.

The papulary pores are small, and about six surround each plate; they are wanting in the triangular interradiial areas and along the sides and on the distal half of the rays. In each dorsal interradiial area there are two larger pores, which are usually quite easily distinguished in dry specimens even without removing the granules. They are situated opposite each of the second pair of plates, counting from the interradiial angles, and are at a considerable distance from the marginal plates; they appear to be the genital pores, which are larger and much wider apart than usual.

Our largest specimen has thirty-nine upper marginal plates on each radial side and a corresponding number of inferior marginal plates; the former stand nearly vertically and project but little upon the disk, but along the sides of the rays they advance more and more on the abactinal surface. At first their height is more than three times the length, but the length rapidly becomes greater and the height less, until on the distal half of the ray the form is squarish, with the height only a little greater than the breadth. All the upper plates are covered with rather large, rounded, cylindrical, capitate, unequal granules; the sutures are bordered by a marginal series of small, slightly elongated, clavate papillæ, forming distinct fascioles continuous with those between the lower marginal plates; the granules on the upper part of the plates are but little elevated, but toward the lower end become larger and

more elevated, until close to the lower end some of those on the middle of the plate are relatively larger, higher than broad, with distinctly enlarged or capitate, rounded ends. The lower marginal plates correspond to the upper ones in number and nearly in breadth, but the sutures along the sides of the rays are not always closely coincident.

The plates occupying the interradial regions are nearly horizontal and somewhat wedge-shaped, with the breadth radially more than three times the transverse length, but along the sides of the rays they rise upward more, and the length increases in proportion to the height, as in the case of the upper ones. Their outer surface is covered with rather stout, mostly fusiform, very acute spinules, equal in size; the larger ones in length are about equal to one-half the lesser diameter of the plate, and form three or four irregular radial rows, with the smaller and more slender ones interspersed. All the spines are loosely appressed to the plates and directed upward and outward in the preserved specimens, but they are not closely crowded and are scarcely imbricated. In smaller specimens, about half grown (radius, 60 mm.), the spines on the lower marginal plates are mostly not fusiform, but slender and regularly tapered, and they form but three regular rows on the middle of the plates, while the smaller and shorter spinules are very slender and much more numerous. The edges of these plates are bordered by one or two rows of small, slender, elongated, short, curved spinules or papillæ, which meet across the rather deep sutures, thus forming distinct but loose fascioles. The actinal interradial areas are large and covered with a close pavement of plates, with their outlines concealed by the integument in well-preserved specimens; when the spinules are removed, the plates are squarish with rounded corners, strongly convex, with deep, groove-like sutures between them; they are somewhat irregularly arranged, and form a pavement-like area, in which the rows next the adambulacral plates are parallel with the latter and the outer ones are parallel to the marginal plates, and slightly imbricated; the inner ones are smaller and more numerous than the adambulacral plates, usually one, but frequently two, corresponding to each adambulacral plate; in general they are arranged so that two rows start from each marginal plate, and each row runs to a single adambulacral plate, but an additional row is interpolated in some cases. The row of these plates next to the adambulacral extends out to about the middle of the ray, the distal plates becoming small and narrow. Each of the interradial plates, except those next to the adambulacral series, bears on the middle, one to three, or more, rather large, fusiform, acute spinules, similar to the larger ones on the lower marginal plates, and an irregular open marginal series of much smaller and more slender spinules of nearly the same form, but the plates next the adambulacral have their lateral margins bordered by a regular close series of flattened papillæ, forming distinct fascioles; and occasionally similar fascioles appear on a few of the other plates of the second row. The

adambulacral plates are narrow on the actinal surface, but their inner margin near the adoral end projects into the groove, forming there a prominent angle and leaving deep and broad incurved notches between them; the actinal portion of the projection is rounded and convex, and from its margin arises the furrow-spines, which are nine or ten in number and form an angular group corresponding to the actinal outline of the plate; these spines are subequal, rather slender, elongated, often a little bent outward, and usually laterally compressed and blunt at the tip; they are more or less united at base by a web-like membrane. The small convex actinal surface of the plates bears a central group of about three or four longer, thicker, round or fusiform, usually acute and rough spines, similar to the larger ones of the adjacent interradial plates; beside these there are several much smaller, slender spinules on the outer margin in a curved row. The jaw-plates are rather large and thick, with sharp, nearly vertical, high inner angles, and with a thick, moderately elevated, actinal keel, separated by a rather wide, elongated median suture. Each jaw-plate bears a row of numerous (about eight) slender spines along the edge, next the groove; these are continuous, with a row of four to six similar spines on the inner, vertical margin. Each actinal keel of the jaw bears two irregular rows of slender, excurved, rough spines, ten or twelve in each row; these spines are similar to the larger ones of the interradial plates, but are rather more slender. The ambulacral feet are very large, furnished with a terminal sucker, and occupy the notches between the projecting adambulacral plates.

Taken by the U. S. Fish Commission steamer *Albatross* in 1886 at station 2706, off George's Bank, N. lat. $41^{\circ} 28' 30''$, W. long. $65^{\circ} 35' 30''$, in 1,188 fathoms, 7 specimens (No. 14944, U. S. N. M.). Also at other stations in 1883, in 123 and 1,255 fathoms.

Variations.—The variations, so far as observed, are probably all due to difference of age. The smallest specimen has the lesser radius, 12 mm.; the greater, 35 mm. This has 27 marginal plates, both above and below. The granulations on the upper marginal plates are more uniform than in the large specimens, those near the lower end of the plate not being much longer than the upper ones, but otherwise they have the same character and are pretty evenly spaced. The paxillæ of the dorsal surface are much smaller and mostly circular, or nearly so; the larger ones have three to nine central granules and twelve to eighteen marginal papillæ. The madreporic plate is very small, about midway between the center and the margin. The spinulation of the inferior marginal plates and interradial region is similar to that of the larger examples, except that the spinules are smaller and more slender. In the furrow series each group contains seven or eight spines, which are slender and slightly excurved, but they are arranged as in the adult; the actinal surface of the plate often bears one or two larger central spines, with four or five smaller and more slender ones on the outer

margin. The jaw-spines are slender, but three or four of them, at the inner end of the incurved jaw, are much stouter than the rest; the inner end of the jaw is prolonged inward and upward to an acute tip.

This species is more closely allied to *P. intermedius*, Sladen, than to any other species hitherto found off our coast. The latter has a smaller disk, with the upper marginal plates projecting farther inward, thus producing a broader margin and a narrower paxillary area along the rays; its paxillæ are smaller in specimens of the same size, more closely crowded, and have the granules closely crowded together and angular, the whole set forming a compact group, in which the marginal papillæ differ but little from the other granules. The upper marginal plates are also much more closely and uniformly covered with granules, which are so closely crowded together that they have a polygonal form, especially on the upper portion of the plates, where they are smaller than below.

The lower marginal plates are also much more densely spinulated and usually have but a single series of a few enlarged, median spinules, not much larger than the rest, while the others are small, short, appressed, crowded, and more or less closely imbricated; those on the lower part of the plate are ovate and often subacute, while those at the upper end of the plate become polygonal and granule like, and similar to those of the upper plates; their marginal papillæ are also characteristic, being short, thick, angular, and very closely arranged in a regular row. The interradial areas are relatively smaller, with more numerous, closer, and smaller, shorter spinules, of which one, a little larger and longer, usually occupies the center of each plate, while the others mostly surround the margin and form distinct fascioles between most of the plates in our numerous specimens (though, according to Sladen, no fascioles existed in his specimens). The adambulacral spines are more equal and form more regular and more prominent groups, the outer marginal ones being more numerous and forming a more regular, divergent, curved series, while the central ones form a group of five to seven larger ones, about equal in length and size to the furrow series; the latter form an angular group of seven to nine, which are usually strongly transversely compressed and blunt. The jaw-spines are much more numerous, stouter, and more crowded; they form a conspicuous, broad-ovate group on the actinal surface of each jaw, with the narrow suture in the middle.

This species has a striking resemblance to *Isaster bairdii* in form and in the character of the abactinal region and upper marginal plates. The disk, however, is somewhat smaller and the rays relatively longer. The paxillæ are a little smaller and the granulations somewhat finer in specimens of the same size; moreover, their marginal granules are finer instead of coarser, as in the latter. However, the strong spinulation of the lower surface and inferior marginal plates is widely different from the even granulation of *I. bairdii*. The angular groups of adam-

bulacral spines also give a very different character to the inferior surface.

Family ASTROPECTINIDÆ (Gray, 1840) emended.

ASTROPECTEN AMERICANUS, Verrill.

Archaster americanus, VERRILL, Amer. Journ. Science, xx p. 102, 1880.

This abundant species appears to be a true *Astropecten*, although a dorsal pore is visible. It has well-developed superambulacral plates. It is more nearly allied to the East Atlantic species, *A. mesactus*, than to any other species described by Sladen. It differs from that species in having longer arms and a much smaller disk; in having longer and more slender marginal spines, and of these usually but two, sometimes three, on each of the inferior row of plates, instead of four or five; in the numerous long, slender spinules of the rest of the surface of the inferior marginal plates; in the long, slender spinules of the dorsal paxillæ, and in the longer and more numerous adambulacral spines.

LEPTOPTYCHASTER ARCTICUS, Sladen.

Leptoptychaster arcticus, SLADEN, *op. cit.*, p. 189.

Astropecten arcticus, M. SARS, Reise, Lofoden and Finnmarken, Nyt. Mag. Nat., VI, p. 161, 1851.

Archaster arcticus, VERRILL, Amer. Journ. Science, xvi, p. 214, 1878

Leptoptychaster arcticus, var. *elongatus*, SLADEN, *op. cit.*, p. 189.

Our series of specimens show various gradations in the relative length of the rays, some of them agreeing in this and other respects with the form described as a variety by Sladen. His variety was taken off New Jersey, in 1,350 fathoms. I am unable to make out any definite diagnostic characters for this form.

This species has been taken at many stations off our coast, in 50 to 547 fathoms, but always in small numbers.

PSILASTER FLORÆ, Verrill.

Archaster floræ, VERRILL, Amer. Journ. Science, vol. 16, p. 372, 1878. Rep. U. S. Com'r Fish and Fisheries, xi, p. 542, pl. 13, fig. 36, 1885

This species clearly belongs to the genus *Psilaster*, as defined by Sladen. It is closely allied to *P. andromeda*, of Northern Europe, and may eventually prove to be only a variety of that species.

It approaches nearest to those specimens of the latter, mentioned by Sladen, having broad superior marginal plates and well developed spines in a submarginal row on the lower series. Some of the larger examples have a single, enlarged, acute spinule, like those of the lower series, on some of the superior marginal plates.

This species has been taken at numerous stations by the U. S. Fish Commission in 72 to 984 fathoms.

A considerable number have also been received from the Gloucester

fishermen, taken on the fishing banks off Nova Scotia and Newfoundland, in 84 to 230 fathoms.

BATHYBLASTER ROBUSTUS, Verrill.

Archaster robustus, VERRILL, Amer. Journ. Science, xxix, p. 383, 1885.

Phoxaster pumilus, SLADEN, *op. cit.*, xxx, p. 236, pl. 15, figs. 3-6; pl. 40, figs. 7-11, 1889 (Young).

This species is evidently very closely related to *B. pallidus*, of Northern Europe, the type of the genus *Bathybiaster*. It is even possible that they may prove to be identical when a full series of each can be compared.

The form described as *Phoxaster pumilus* by Sladen, which was taken off the North American coast, in 1,240 to 1,700 fathoms, appears to be identical with the young of our species. His specimens were only 62 mm. in diameter. The genus *Phoxaster* in this case becomes a synonym of *Bathybiaster*.

Fully grown examples of *B. robustus* are often 250 to 280 mm. in diameter.

In the young specimens, up to about 75 mm. in diameter, the central "epiproctal cone" is still visible as a low wart-like elevation, with an aperture in the tip, but in the large specimens it disappears entirely and the central area of the disk becomes flat, or even concave, and covered with crowded paxilliform plates much smaller than those on the rays, but the small central pore is persistent. The peculiar purse-like or bursiform pedicellariæ of the large inner adambulacral spines, characteristic of *Bathybiaster*, are often entirely wanting in our specimens, especially when small, and usually, when present, there are but few of them even in the large specimens. Possibly they may have been destroyed by rough usage in the dredges and washing sieves. The squamiform spinules and pedicellariæ of the actinal and marginal plates are like those of *Bathybiaster pallidus*. The two rows of spinules on each jaw-plate are peculiar, for the opposite spines of each pair press their tips together something like the valves of certain pedicellariæ, but this seems to be the case in the European form also. These spines are subequal in length—short, with flattened blunt tips; those of the actinal series, in large specimens, are stoutest, often with enlarged, truncate, bilobed, or rough ends; there may be 15 to 20 in each row. The two close parallel rows of spines on the first adambulacral plates are similar in form and arrangement. Of these there may be 10 to 12 in each row. The adambulacral plates, except the first pair, correspond in number to the marginal plates. The actinal interradial plates form short, simple rows running from each plate to a corresponding marginal plate; their marginal scales form narrow fascioles, which become more distinct and regular in the narrow, continuous vertical grooves between both series of marginal plates. The longitudinal sutures between the upper and lower plates are very

inconspicuous. The small, conical, marginal spine on the upper edge of each of the superior plates is relatively shorter and stouter in the large specimens than in the smaller ones; sometimes there are two of them side by side. Taken at many stations, in 705 to 1,467 fathoms.

Family PENTAGONASTERIDÆ, Perrier.*

PARAGONASTER FORMOSUS, Verrill.

Archaster formosus, VERRILL, Amer. Journ. Science, XXVIII, p. 383, 1884.

?*Paragonaster cylindratus*, SLADEN, *op. cit.*, p. 314, pl. 51, figs. 3, 4; pl. 53, figs. 3, 4, 1889.

Our species appears to be very closely allied to the form well described and figured by Sladen from off the Cape Verde Islands. Our species appears to have the adambulacral plates more salient and angular on the furrow-margin, and the notches between them deeper; the furrow-spines appear to be more slender and form a more strongly curved or angular group, which is continued by three to five shorter ones in a fasciole-like row on the proximal and distal edges of the plates; there are about five on the furrow-edge proper; the spines on the actinal surface are more elongated and more regularly stellate, with a longer one in the middle of the group.

The spinules of the lower marginal plates have the same arrangement as in Sladen's species, but are slightly more slender and acute than shown in his figure; of the larger median series there are usually two or three irregular, indefinite rows in the larger specimens, instead of a single definite row. These differences are, however, so slight that the two forms may eventually prove to be the same species.

Narrow, imperfect fascioles occur between the marginal and actinal plates in our species.

The distinction between *Paragonaster* and *Pseudarchaster* seems to me very slight, depending almost entirely upon the narrow abactinal area of the rays in the former.

This species was taken at several stations in 1,396 to 2,031 fathoms.

ISA S T E R, new genus.

It seems necessary to institute a new generic group for the elegant starfish formerly described by me under the name of *Archaster bairdii*. It cannot be placed in any of the numerous genera proposed by Sladen without changing the definitions considerably. It appears to be most nearly allied to *Mediaster*, *Paragonaster*, and *Nymphaster*. It might be defined as a *Nymphaster* with broad rays having wide abactinal areas.

The form is stellate, with a rather broad disk and tapering rays, having rather wide abactinal areas. The marginal plates are well developed in both series, but the upper ones are flattened above, or bevelled, and do not form a wide margin on the disk; they are all paired, and those of the two series are nearly opposite each other. They are everywhere

* *Goniasterida* is an earlier and better name for this group.

granulated, without spines, and have differentiated marginal granules along the sutures, forming narrow fascioles. The abactinal ossicles are mostly parapaxillæ, regularly arranged in several longitudinal rows along the middle of the rays, with the central row clearly defined; they are closely and evenly covered with angular granules, those around the edge differentiated. The papulæ are restricted to the central part of the disk and the baso-median part of the rays.

The actinal interradial areas are large and covered with many more or less rhombic plates closely arranged in regular rows parallel with the ambulacral grooves. The plates are covered with even granules similar to those of the upper surface.

Some of the actinal plates usually, but not in all specimens, bear small valvate pedicellariæ, usually with two or three valves, similar in size to the granules; similar pedicellariæ may occur in small numbers on the marginal and abactinal plates.

The armature of the adambulacral plates is in longitudinal rows, usually three rows to a plate.

The jaws are not prominent on the actinal side; they have marginal and actinal rows of spines. The ambulacral feet have terminal suckers.

This genus differs from *Nymphaster* chiefly in having broad abactinal areas on the rays. From *Paragonaster* it differs in that character and also in having the actinal plates evenly granulated, and the furrow-spines in a straight row.

The pavement-like arrangement of the actinal plates, the granulation of the plates, and other characters indicate that it belongs to the family *Pentagonasteridae*, as limited by Sladen.

ISASTER BAIRDII, Verrill.

Archaster bairdii, VERRILL, Amer. Journ. Sci., XXIII, p. 139, 1882.

Disk broad, flattened, or moderately convex, with the interradial margins broadly curved, and the edge evenly rounded, owing to the faint elevation of the upper marginal plates. Rays broad at base, rapidly tapered to rather slender tips. Lesser to the larger radius about as 1 to 2.5. Lesser radius of one of the largest specimens, 23 mm.; greater radius, 54 to 56 mm. Another specimen has the lesser radius 18 mm.; greater, 53 mm.

Abactinal area of the disk and rays closely covered with rather large crowded parapaxillæ, which are round or polygonal according to the amount of crowding, with a median row along the rays slightly larger than the others. The parapaxillæ consist of a round, convex, cylindrical or slightly clavate column, arising from the center of each of the plates. On the middle region of the basal portion of the rays, the plates are united by more or less stellate processes so as to leave large intervening pores for the papulæ; but in the triangular interradial areas the plates are closely united, without pores between them. On these areas they become protopaxillæ, and are closely crowded in rows

parallel to the marginal plates; next the marginal plates they become much smaller than elsewhere and squarish or hexagonal in form, while the central column becomes reduced to a slight elevation of the surface. These small plates, without interspaces, also extend along the margins of the rays and fill up the entire abactinal area of the arms beyond the distal fourth, where there are about five rows. In the central area of the disk the central and ten primary plates are larger and more rounded than those upon the rays; and the papular pores are smaller and less numerous than upon the rays, so that the areas having pores form a five-rayed star upon the disk and arms, which is conspicuous when the granules are removed. The petal-like groups of papular pores are also often distinctly visible in dry specimens without the removal of the granules.

Each of the dorsal plates bears a very even and regular flat or concave group of papilliform granules; each group consists of a central cluster of from twelve to twenty-five rather small rounded granules, slightly separated from each other, and of a marginal series of fifteen to thirty or more, somewhat longer, very even, flattened, blunt papillæ, which are somewhat divergent, so that those of the adjacent groups are nearly or quite in contact, except where the papulæ come forth. Owing to the somewhat greater length of the marginal papillæ the central area of the whole group is lower than the margin. Some of the smaller groups, towards the sides of the rays contain but six to ten granules in the central cluster, in the midst of which one, slightly the largest, is central and the others form a circle around it. Close to the marginal plate, in the interradial areas, where the plates are most crowded, the granules become very uniform in size and elevation, so that the separate groups are scarcely distinguishable and the granulation is nearly identical with that on the marginal plates.

On several of the largest specimens many of the dorsal plates, both of the disk and rays, bear a single, small, subcentral or marginal bivalved pedicellaria, which is a little higher than the adjacent granules and two or three times as broad; seen from above the outline is oblong; each one appears to take the place of from two to four granules. Sometimes two such pedicellariæ occur on the same plate, and occasionally they have three valves. Those that occur near the interradial margins are smaller than those on the central area. The valves are flat, incurved, and truncate at the end.

The madreporic plate is small, with few branched gyri, and is situated much nearer to the center than to the margin; in a specimen having the lesser radius 22 mm. the madreporic plate is 7 mm. from the center. The central or anal pore is usually small and inconspicuous, but in some specimens it is very evident and is surrounded by a convergent group of numerous small spinules. In the papular areas at the bases of the arms the pores are large and each has a single papula; usually each plate is surrounded by six pores.

The upper and lower marginal plates closely correspond in number and elevation. The superior ones are scarcely raised above the level of the disk, so that they are not conspicuous, as seen from above. In the interradial areas they are nearly twice as high as long, but beyond the middle of the arm they become squarish in form; their surface is but slightly convex; they are separated from each other and from the inferior plates by shallow and narrow grooves, which are bordered by a row of small granules or papillæ a little longer than those that cover the rest of the plate, so as to form simple fascioles. In the largest specimens there are about twenty-five superior marginal plates on each side of a ray. The inferior plates are nearly the same as the superior ones in size and form and in the furrows or fascioles between them, but the sutures do not always correspond precisely with those of the upper series. The entire outer surface of the marginal plates of both series is covered with small granules separated by intervals less than their own diameters.

The interradial areas beneath are rather large, triangular, and occupied by groups of closely united, convex, polygonal, and squarish plates, similar in size to the larger ones of the dorsal surface and covered by even groups of granules, much like those of the dorsal surface, but a trifle larger and higher. These plates form four or five regular rows parallel to the adambulacral plates on each side, beside a small triangular group next the center of the interradial margin; their regular arrangement and squarish form allows narrow furrows to run from between the adambulacral plates to the marginal plates in both directions. Those in the row next the adambulacral plates correspond nearly to the latter in number and breadth; this row extends to a point about opposite the eighth marginal plate of the ray, the distal plates becoming small and irregular and only filling the angles between the adambulacral and marginal plates; but within the limits of the disk the plates of this row are nearly square, with rounded corners. The granules covering these actinal plates are somewhat elevated, with rounded and somewhat swollen tips, the marginal series on each plate being somewhat longer and more divergent than the rest, so as to form rudimentary fascioles between the plates. The number of granules on the larger plates is usually from fifteen to twenty, of which three to six occupy the center of the group, while the others are often arranged so as to form pretty regular square or rhombic groups, giving a very even and symmetrical arrangement to the whole area. On some of these plates, near the mouth, one of the central granules is replaced by a small bivalved pedicellaria, similar in size and form to the adjacent granules, but they do not appear to be present on all specimens. In some specimens these pedicellariæ become decidedly larger and are furnished with three, four, and even five valves surrounding a central or subcentral pore in a plate; in this case they take the place of the central group of granules and become more numerous and occur on about one-third of all the

interradial plates. On such specimens more or less similar two-valved pedicellariæ are found on the marginal plates and on the abactinal plates of both the rays and disk. The adambulaeral spines consist, in the larger specimens, of an inner or furrow-group of five or six rather slender elongated spines, which arise from a curved and prominent base line and project inward in a more or less divergent group, in which the middle spines are somewhat longer than the rest; these spines are mostly flattened in a direction transverse to the rays and are subacute at the tip; external to these, on the actinal side of the plate, there is a somewhat curved longitudinal row of about six spines, which are much shorter than the inner ones, their length being less than half, while the three middle ones are also somewhat stouter than the inner or furrow-spines, and considerably larger than those adjacent to them in the same row; each plate bears also an outer, incurved marginal series of short, blunt spinules, scarcely larger than and similar to the granules of the adjacent plate. They form a marginal row around the outer portion of the plate, and often form, with the median series, a more or less circular or elliptical group, external to the furrow series; but in other specimens the two sets appear rather as parallel, longitudinal rows. The furrow ends of the adambulaeral plates are broadly curved and prominent and project somewhat into the furrow, leaving rather deep indentations between them, which form rudimentary fascioles.

The jaws are furnished with numerous rather stout, flattened spines, of nearly equal size; of these, about three projecting inward from the angle of the jaw are a little the longest, and the median one is a little more prominent than the others. Distal to these, on each margin there may be eight to ten somewhat smaller, blunt, transversely compressed spines standing in a single row. The actinal surface of the jaw-plates is slightly convex and but little prominent, the two plates forming together a broad oval, upon which, proximally, there is a pair of short, rather stout, angular spines, which form the apex of an oval group of smaller and shorter spines, formed by two rows on each half of the jaw; the more distal of those of the outer row, and all those of the inner rows, are similar in size and form to the granules of the adjacent interradianal plates.

This species was taken by the U. S. Fish Commission steamer *Albatross* in 1882 at station 1122, off Martha's Vineyard, in 351 fathoms, and at five stations, in 1885, between N. lat. $42^{\circ} 55' 30''$, W. long. $50^{\circ} 51'$, and N. lat. $39^{\circ} 47' 07''$, W. long. $70^{\circ} 35'$, in 471 to 721 fathoms.

Most of the specimens, including all the larger ones, were taken at stations 2429 and 2552, in 471 and 721 fathoms.

Variations.—The essential characters of this species do not vary largely in specimens much smaller than those described. The smallest specimen seen has the radius of the disk 8 mm. and that of the rays 18 mm. This specimen agrees closely with the largest in general appearance and most of the details of structure. But the dorsal parapaxillæ

are naturally smaller and are occupied by a much smaller number of granules, there being on the median row of the rays about ten or twelve marginal and three or four central granules. The primary plates are relatively larger than in the adults. The larger ventral interradial plates have about seven to ten marginal granules, and usually but one in the center. The spines of the adambulacral plates form three pretty regular longitudinal rows; those of the inner or furrow-series are long and slender and form a divergent group, usually of four on each plate; in the second row there are mostly four, which are much stouter, on each plate; the outer row consists of from three to five on each plate, similar to the adjacent granules. On the young specimens up to 50 mm. in diameter no pedicellariæ have been observed. A few often occur on specimens 70 mm. in diameter, but they are often absent from the largest sized specimens.

Most of the specimens from station 2429 have the arms somewhat longer and more attenuated distally than in the typical specimens. One of these, having the radius of the disk 14 mm., that of the rays 42 mm., has the rays 6 mm. in the breadth in the middle, measuring from the mouth.

A single six-rayed specimen occurred at station 2429. This is 54 mm. in diameter; radius of the disk 10.5 mm. It agrees pretty closely with the five-rayed specimens of similar size, but the granules of the actual plates are smaller and more numerous than usual, and many two-valved pedicellariæ occur upon both the dorsal and ventral plates. In this specimen the furrow-series of adambulacral spines consists of groups of six and sometimes seven on each plate.

GENUS ODONTASTER, VERRILL.

Odontaster, VERRILL, Amer. Journ. Science, xx, p. 402, 1880.

?*Gnathaster*, SLADEN, *op. cit.*, p. 185, 1889.

This genus has a broad, stellate form, usually five-rayed. The abactinal surface is covered with elevated, round parapaxillæ, bearing spinules. The papulæ occupy the center of the disk and the median part of the rays. Marginal plates convex, the two series about equally developed with an odd interradial one in each series. Imperfect fascioles occupy the sutures. Upper marginal plates covered with fine spinules; lower ones with larger spines, similar to those of the lower surface of the disk. Actinal plates numerous, pavement-like, in rows parallel to the furrows, each with a group of erect spines. The adambulacral plates are rather rectangular, with a furrow series of few large spines in a simple row, and an actinal group of similar large spines. Each jaw has on the actinal side and near its inner end a large, sharp median spine or tooth-like process, which is directed outward. The jaws have marginal and actinal rows of spines similar to those of the adjacent plates. No pedicellariæ have been observed.

In most respects the genus *Gnathaster* of Sladen is identical with

Odontaster. The large, median, sharp, recurved spine or "keel" of the jaw is the same in both, and the same is true of the general structure of the skeleton. But *Odontaster* is much more spinose, both above and below, than any of Sladen's species. The latter have more evidently paxilliform plates on the actinal surface, bearing small spinules or papilliform granules, while in the type of *Odontaster* all the ventral plates are densely covered with long, robust, erect spines, nearly equal in length.

ODONTASTER HISPIDUS, Verrill.

Odontaster hispidus, VERRILL, *op. cit.*, p. 402, 1880.

This form is regularly stellate, with a rather broad, flat disk and tapering, subacute rays, which are usually 5, but sometimes 6. The dorsal surface of the disk and rays is covered with spinulated parapaxillæ; over most of the surface these have a rather high, round, central column, convex at summit, and covered with a dense radiating group of long, slender, sharp spinules, often 20 to 26 on each; the marginal spinules are smaller and mostly divergent. Toward the margins of the interradial areas and rays the central column of the plates becomes gradually smaller and shorter, becoming verruciform and quite small on the outer plates, which are closely crowded and without intervening papular pores.

The papule, in specimens 20 to 30 mm. in diameter, are arranged in a broad ovate group at the base of each ray, and in a disconnected central group on the disk, but in large specimens the central group becomes connected with the others by a narrow median band; the papule do not extend quite to the end of the rays in the largest examples, but reach to about the distal third. The madreporic plate is of medium size, with fine gyri, and is surrounded by a ring of about 6 paxillæ.

The marginal plates are all convex, with deep rounded sutures, in both directions; the upper ones rest largely on the dorsal side. There is an odd interradial marginal plate in each series, very similar to the others, but a trifle more wedge-shaped. There are usually 17 to 19 plates in each series, in the larger specimens; they are opposite each other. The apical plate is small and pear-shaped.

The upper marginal plates are densely covered with small, slender spinules, like those of the dorsal paxillæ, and the marginal ones are smaller and form narrow fascioles.

The inferior marginal plates are densely covered with similar spines, which are a little more acute, but they have very slender spinules along the sutures, forming imperfect fascioles. The actinal plates are numerous, thick, rather squarish, but with rounded angles and a convex surface, with pits where the spines are removed; they are arranged in rows parallel to the furrows, except close to the margin, where they become small, irregular, and crowded; those in the first row are longer radially than the adambulacral plates, so that they are fewer than the

latter; those in the other rows have a tendency to stand opposite those of the first series, those in each succeeding row being smaller, but this arrangement is not entirely regular. The first row of actinal plates extends to within a short distance from the end of the rays, only the last 4 pairs of marginal plates being without them, but they become small and narrow distally.

The adambulacral plates are rectangular, shortest radially, convex, separated by well-marked sutures. The larger specimens have either 2 or 3 rather long and nearly equal, erect, furrow-spines, on each plate, and about 5 or 6 similar, but slightly larger, erect spines on its actinal surface; these spines are all pointed and quite identical, in size and form, with those of the adjacent plates.

Specimens of ordinary size have the smaller radius about 16 mm.; the larger radius 40 to 42 mm. A few 6-rayed specimens have occurred. This species was taken at a large number of stations by the U. S. Fish Commission, in 43 to 1,230 fathoms, between N. Lat. $35^{\circ} 14' 20''$ and $40^{\circ} 10' 15''$.

PENTAGONASTER EXIMIUS, new species.

A small, flat species, with a broad, pentagonal disk, nearly rectilinear on the interradial margins, and with small, short, narrow rays, which are obtusely rounded at the end, owing to the presence of a rather large apical plate. The lesser to the greater radius, as 1 to 1.75. Lesser radius of the best specimen, 16 mm.; greater radius, 25 mm.; elevation of the margin of the dry specimen, 3 mm.; length of the largest marginal plates, 2 mm.; diameter of the largest dorsal paxillæ of the rays, 1.2 mm.

The abactinal surface is closely covered by nearly flat, rather large, closely granulated plates, which, in the radial areas, are regularly hexagonal at summit, a central median series being distinguishable, though scarcely larger than those adjacent. The central area of the disk is occupied by angular plates, more irregular in size and form, among which all the central and the 10 primary radial and interradial plates can be easily distinguished by their much greater size and more numerous granules, their diameter being about 2 mm., and the number of granules more than 100. The large triangular interradial areas, destitute of papulae, are occupied by very closely arranged angular plates, some of which are rhombic, others trapezoidal, and some subtriangular, those nearest the marginal plates being smaller than the others, but all are covered with a uniform granulation. On the larger radial plates there is a central group of 15 to 20 closely packed, rounded granules and a marginal series of from 20 to 25 angular ones. On the distal part of the rays the median plates become smaller and more irregular, and have no intervening papulae, and between the last three pairs of marginal plates they are absent. The madreporic plate is small, angular, and nearer to the center than the margin (distance from center, 6 mm.); it has rather few convoluted gyri.

Of the upper marginal plates there are 8 on each radial margin, and of the lower plates, 9, including a very small one next the apical plate. The larger plates of the upper series are nearly rectangular in outline, but rather higher than long; as they approach the end of the rays they become relatively shorter, until, near the end of the ray, the length is about one-half the height. The inferior plates are about equal in size to the upper, and stand nearly opposite to them, but the sutures do not correspond closely; the larger part of their surfaces extend upon the actinal side of the interradial region. The entire surface of the plates of both series is densely covered with small polygonal granules, except a small, rounded, or oval, bare spot on the upper end of each superior plate, and near the lower margin of each inferior plate; but these smooth bare spots are occasionally wanting, and vary in size, indicating that they may have been caused by injury before capture, for the plates are pitted where the granules have subsequently been removed.

The large interradial areas of the actinal side are occupied by a close pavement, mostly of rhombic plates, which are mostly arranged in rows parallel to the ambulacral groove. Each plate is covered by a compact group of angular granules, usually 10 to 15 on each plate; these granules are coarser and more elevated than those on the surface of the marginal and dorsal plates, but they are all similar and of the same height, producing a very even surface. The adambulacral plates are arranged in 3 nearly regular longitudinal rows; the furrow-series consists usually of 3 nearly equal spines which are moderately stout, not very long, mostly flattened, and obtuse; the next series is formed by 2, somewhat flattened, blunt spines, side by side, on the actinal side of each plate; these are a little shorter, and decidedly stouter than the furrow-series; the outer series is formed by 3 small, equal, angular, granule-like spinules on the outer margin of each plate; they are similar to and only slightly longer than the granules of the adjacent plates. The jaws bear, on each side, a row of 8 or 9 rather stout and short angular spines of which the innermost are a little the largest and also a row of similar spines, of about the same size, on each actinal border, with a few smaller ones in a group at the distal end. The jaws have no distinct actinal keel.

This species was taken by the steamer *Albatross* in 1883, off La Have Bank, at station 2064, N. lat. $42^{\circ} 25' 40''$, W. long. $66^{\circ} 08' 35''$, in 122 fathoms, and in 1885 off Nova Scotia at station 2507, N. lat. $44^{\circ} 27' 30''$, W. long. $62^{\circ} 33' 30''$, in 80 fathoms. A single specimen was obtained at each locality.

This species is closely allied to *P. granularis*, which is also found in the same region. The latter differs in having the interradial margin more regularly incurved, with the rays relatively longer and more regularly tapered and the tip less acute, owing to the smaller size of the apical plate; the granulations of the abactinal marginal plates are also

coarser and less even, and not so numerous; the primary interradial plates are relatively much smaller and less distinct from the others; the madreporic plate is finely cancellate; the adambulacral plates bear more numerous, stouter, and more angular spines; in the furrow-series there are usually four or five spines; on the middle of the actinal surface three to five stout, blunt, angular spines; and on the outer margin usually three or four short, thick, angular, granule-like spines.

Remarks on the characters of the preceding families.

The preceding families Archasteridæ, Astropectinidæ and Pentagonasteridæ, as limited by Mr. Sladen,* are not well defined, nor do the few characters given by him hold good in all cases.

The existence of superambulacral plates has been supposed to be characteristic of the Astropectinidæ only, but they exist in several of the genera referred to Archasteridæ, viz., *Dytaster*, *Plutonaster*, and *Pseudarchaster*.

The apoctous condition, supposed to be characteristic of the same family, is unreliable, for in nearly all the genera referred to it by Mr. Sladen there is a perfectly well defined dorsal or "anal" pore appearing just as in the Archasteridæ, and in some of the genera the pore is even elevated on the summit of a dorsal cone or chimney (*Psilaster*, *Ilyaster*, etc.). This pore serves in each of these families (and in Asteroidea generally) for the discharge of the secretion of branched dorsal glandular organs, probably nephridial in function, situated above the stomach.

Whether the central pore serves as a true anus in any of these starfishes is very doubtful, for the intestine is usually nearly or quite abortive. In any case it is impossible to ascertain this point without actual dissection of alcoholic or fresh specimens, which are often not available.

The distinctions between the Pentagonasteridæ and Archasteridæ are also very faint and indefinite, for although the typical genera of each group appear to be very different, there are many intermediate genera now known, so that there is probably not one diagnostic character that can be given to separate the two groups as limited by Sladen. If the two families are to be preserved, it will probably be necessary to change their limits and to transfer some of the genera.

It would, perhaps, be more in accordance with a natural classification to drop the family Archasteridæ and distribute the genera referred to it among those of the other two families. In such a system those genera having distinct fascioles between the marginal plates and between the infero-radial plates would belong with the Astropectinidæ, while those without fascioles would be placed in the Pentagonasteridæ or Goniasteridæ.

By this rearrangement the former family would include mostly those genera covered with true paxillæ and parapaxillæ, and the latter would

* Voyage of the Challenger, xxx, pp. xxviii-xxxI, 1, 174, 260, 1889.

include mostly genera covered with spinous or granulated plates, propaxillæ, or pseudopaxillæ.*

The various kinds of abactinal ossicles pass into each other by various intermediate forms, so that it is impossible to draw any very strong or sharp family lines on this character alone, though the character of the plating may generally be taken as of generic value.

The existence of definite fascioles of specialized spinules or papillæ on the margins of the plates, so as to form covered channels along their sutures, is evidently a character both of morphological and physiological importance. The existence of fascioles is correlated with the mode of life. Such forms as have them appear to live more or less buried in soft mud or sand and the fascioles are evidently for the purpose of providing a free circulation of water around the whole surface of the body, both to provide for respiration and to keep the surface of the body free from dirt. The paxilliform plates also contribute to both these functions.

The typical *Astropectinidæ* are among those best provided with fascioles and with the most highly developed forms of paxillæ. They are also those that are eminently dwellers in and beneath mud and sand. The pointed form of the ambulacral feet is correlated with the same habit.

The family *Porcellanasteridæ* includes *Ctenodiscus*, *Porcellanaster*, and allied genera, which have similar, but even more specialized, structural adaptations for the same purposes.

Within the limits of the family *Archasteridæ* Mr. Sladen made four

* It seems desirable to have special terms to designate these various forms of dermal ossicles, which are generally included rather indefinitely under the terms paxillæ and pseudopaxillæ. As understood by me, true *paxillæ* are columnar or hour-glass-shaped ossicles with narrow, usually isolated, bases, which bear at summit a group of small spinules, of which the marginal series are usually different from the rest and divergent, so as to cover the intervening spaces between the spines. These are highly developed in most species of *Astropecten*.

Spinopaxillæ are of the same general structure, but the center of the summit is occupied by a distinct spine, or by more than one. Such forms occur on *Luidia*, *Pontaster*, etc.

Parapaxillæ are lower and broader, rounded ossicles, or angular plates with a raised central portion, or like a low column; they may be either isolated or articulated by their bases; the summit is covered with small, short, differentiated spinules, much like those of true paxillæ. Those on the dorsal surface of *Plutonaster* are examples. They sometimes bear a central spine.

Protopaxillæ are similar, but less elevated convex ossicles or plates, covered with round or angular granules, with the marginal series differentiated and more or less covering the grooves between the plates. As in the preceding, there may be a central spine in some cases. This form occurs on *Plutonaster*, and on many species of *Pentagonasteridæ*. The transition from this last kind to simple, uniformly granulated plates is easy, when the grooves between the plates become obsolete.

Pseudopaxillæ are plates with flattened, often lobed or branched, and mostly overlapping bases, which bear a group of slender, fascicled spinules, on the more or less raised central or subcentral area. These have no differentiated marginal series of spinules. This form is well seen in *Solaster*, *Cribrella*, etc.

subfamilies. These are mostly small groups of genera that have more or less close relations to each other, but the distinctions between some of them seem to me too slight for even subfamily groups. Every new genus discovered is likely to break down some of the distinctions made between such groups. Moreover, some of the distinctive characters given by Mr. Sladen do not hold good for the genera classified by him. Thus, the subfamily *Pararchasterinae* is said to have the papulae "confined to a limited area at the base of the rays," while the subfamily *Plutonasterinae* is said to have them "distributed over the whole abactinal area." But, as a matter of fact, scarcely any of the genera referred to either of the subfamilies have the papulae so distributed, and in many of the genera they can be best described as confined to the central part of the disk and to the median or radial areas of the basal part of the rays and disk. They are almost always lacking on the distal and submarginal parts of the rays, and on more or less extensive dorsal interradial areas of the disk. This is the case in *Plutonaster*, *Dytaster*, *Pseudarchaster*, etc., and is also the usual arrangement in the *Pentagonasteridae*.

The genus *Pararchaster*, Sladen = *Benthopecten*, Verrill has essentially this same arrangement of papulae, only they are absent from a somewhat greater portion of the distal part of the ray, but different specimens of the same species vary widely in this respect according to their age. In fact, there is nothing very peculiar in their arrangement in this genus, as compared with various other species formerly included in the genus "*Archaster*," so that when the genus *Benthopecten* was first briefly described by me I did not consider it necessary to refer to this feature, there being various other characters of much greater value.

The special arrangement of the papulae in *Pontaster* is, however, a character of importance. But there is surely no very close affinity shown between *Pontaster* and *Benthopecten* by the arrangement of the papulae.

My own view is that *Benthopecten* may be more closely allied to some of the genera referred to the *Pentagonasteridae* by Mr. Sladen, for it has neither paxillae nor fascioles, but it does have large, odd, interradial marginal plates, a feature found in some of the other genera of the latter family. Probably there should be a special subfamily, *Benthopectininae*, established for it.

On the other hand, a special subfamily, *Pontasterinae*, may well be established for the genus *Pontaster* and allied genera, which are evidently closely related to the more typical genera of *Archasteridae*.

A very remarkable new genus of this group, and apparently closely allied to *Pontaster*, though it has large papular areas, exists on the Pacific coast. It has the following characters:

A CANTHARCHASTER, new genus.

Rays usually five, long, angular, tapered. Disk small; aetinal interradial plates very few, spinous, confined to the disk; marginal plates

of moderate size, more or less alternate, spiniferous; those of the upper series smaller than those of the lower, rounded, with a central eminence bearing a single large movable spine, with a group of small spinules around its base. The plates of the lower series may bear two or more similar large spines surrounded by spinules. The upper marginal plates form a narrow margin along the rays.

The dorsal surface is covered with small, unequal plates in the form of protopaxillæ and spinopaxillæ; the latter have a low, round column and bear a large, central, articulated spine surrounded at base by a circle of small spinules; they are found on the disk and along the median part of the rays. The protopaxillæ are smaller and part of them bear only small spinules; others have a small central spine.

The papulæ cover most of the disk and the entire basal part of the rays.

Peculiar double pectinate pedicellariæ exist on the dorsal surface of the rays and disk, and a single one, of larger size, occupies the center of each actinal interradial area; in one case a similar structure replaces the two upper marginal plates in the interradial angle. These large actinal compound pedicellariæ may have ten to twelve incurved papillæ on each side, while those of the dorsal surfaces have, usually, three to six. Some of the latter have three convergent groups of curved papillæ. The central dorsal pore is very evident and surrounded by papillæ.

The adambulacral plates have a salient inner angle, and bear a divergent group of furrow-spines and a transverse actinal row of long spines.

The jaw-plates are large, and bear simple marginal and actinal series of long spines.

The type (*Acantharchaster dawsoni*, Verrill), originally described* as *Archaster dawsoni*, Verrill, was taken in 111 fathoms off the Queen Charlotte Islands.

Family STICHASTERIDÆ, Perrier.

NEOMORPHASTER FORCIPATUS, new species.

Rays five, high and rounded at the base, tapering rather rapidly to the slender, acute tips, and in the dry specimen showing a distinct, elevated median row of large plates and four lateral rows of somewhat smaller plates on each side. Interbrachial angles subacute; disk rather small, swollen, in the dry specimen depressed in the center. The lesser to the greater radii are about as one to five. Smaller radius of the type specimen, 16 mm.; greater radius, 85 mm.; breadth of arms at base, 19 mm.; height of the arms at base, 16 mm.; diameter of madreporic plate, 4 mm.

The disk and the principal rows of dorsal plates of the rays are

* Report of Prog., Geol. Survey of Canada, 1878-1879.

covered with short, thick, blunt, almost granule-like spinules and with a great abundance of comparatively large crossed pedicellariæ, which are also scattered over all the plates, both of the dorsal and lateral surfaces of the arms and disk; many of these pedicellariæ are nearly as large as the adjacent spinules and about half as thick as the larger spinules of the dorsal series. The rows of plates along the sides of the arms are destitute of spinules, but are thickly covered with pedicellariæ. Adjacent to the adambulacral plates there is a row of stout ventral plates, each of which bears two stout, obtuse, club-shaped spines placed side by side and forming a somewhat irregular row, which terminates before reaching the middle of the arm. Outside of these there is another row of prominent plates, each of which bears one or two small spines toward the base of the arms, but beyond the middle of the arm each bears two spines or sometimes three, like those of the inner row. The surface of these large ventral plates is covered, like the dorsal and lateral ones, with large crossed pedicellariæ. Each adambulacral plate bears two or sometimes three moderately long, round, blunt, and often slightly clavate spines, so arranged as to form two pretty regular rows. Near the mouth each plate usually bears a single spine forming a simple row. Attached to the adambulacral spines and in the ventral interradial spaces are many acute, ovate, forcipate pedicellariæ, often mixed with crossed pedicellariæ and scarcely exceeding the latter in size; along the inner edge of the adambulacral furrow there are numerous smaller pedicellariæ similar in shape. Many of these are raised on slender pedicles; they often form a group of three or four on the inner end of each plate. Jaws elongated, with three or four rather long, round, subacute spines in a row along each side, and with four longer convergent spines at the inner end, two of which are directed upward and inward.

The central part of the disk is covered by a system of rather large primary plates, which form a more or less distinct rosette. The madreporic plate is near the center, moderately large, flattish or somewhat concave, and surrounded by numerous spinules like those of the neighboring plates. It occupies the whole upper surface of a large primary basal plate. The plates of the median dorsal series are rather large and prominent, closely united in a continuous series; their prominent crests are transverse and bear about 10 to 12 spinules, which are arranged in about two irregular transverse rows, intermingled with the pedicellariæ; another row of similar but somewhat smaller plates extends from the dorsal interradial angle to the tip of the arm on each side; this row, at first dorsal, becomes median-lateral at about the middle of the ray. Toward the base of the arm these plates usually bear a transverse row of 2 to 4 small spinules on a distinct crest or ridge, but these mostly disappear before reaching the middle of the arm; between this row of plates and the median dorsal row on the basal part of the arm there is an intermediate row of smaller plates,

most of which bear a small group of spinules and pedicellariæ, but this row becomes indistinct at about the middle of the arm, yet continues to the end. The sides of the arms at the base are occupied by about three rows of large, close plates, mostly without spinules. These longitudinal rows of plates are united by short, stout, transverse processes, so that they leave small rounded interspaces, each of which bears a group of 3 to 6 or more papulæ on the dorsal surface; on the lower lateral and ventral surfaces the interspaces become much smaller, and the papulæ often stand singly. All the plates are very firmly united together, both transversely and longitudinally, so that their outlines can not be distinguished in the dry specimen without maceration.

The ambulacral sucker-tubes form 4 close rows, and are furnished with small terminal suckers.

Two specimens (Nos. 11131 and 11425, U. S. N. M.) were taken in 1885 at stations 2530 and 2531, off George's Bank, in 956 and 852 fathoms; and another in 1886 (No. 14859, U. S. N. M.) at station 2681, off Martha's Vineyard, in 990 fathoms.

The generic position of this singular species is somewhat doubtful. It appears to be more nearly allied to *Neomorphaster eustichus*, Sladen, from off the Azores, in 900 to 1,000 fathoms, than to any other described form. It differs, however, in having more numerous pedicellariæ scattered over the surface, in the greater number of papulæ, in the transverse arrangement of the dorsal spinules, and in having longer and more slender furrow-spines.

Family SOLASTERIDÆ, Perrier.

SOLASTER SYRTENSIS, new species.

Rays usually 9, well rounded above, high at base, regularly tapered, moderately long, the length about equal to the diameter of the disk. Interradial angles subacute, occupied by close pseudopaxillæ. Disk flattened or convex, according to the mode of preservation. Radii about as 1 to 3. In one of the type specimens, the diameter is 165 mm.; lesser radius, 28 mm.; greater radius, 80 to 85 mm.; breadth of rays at base, 18 mm.; height of rays at base, 16 mm.; diameter of dorsal pseudopaxillæ, about 0.75 mm.; diameter of madreporic plate, 3 mm.

The whole dorsal surface and the sides of the rays are closely and evenly covered with rounded, flat-topped pseudopaxillæ, larger and more even than those of *S. endeca*. Those covering the central area of the disk and middle of the basal part of the rays are largest, the size regularly decreasing toward the ends and outer sides of the rays. The spinules on the largest pseudopaxillæ are often 30 to 40 in number, of which 20 to 25 or more surround the margin, while 6 to 12 or more form a central group. They are all similar—small, slender, of moderate length, and rough at the blunt tips, and seem to be united at their bases by a membranous web.

When the spinules are well preserved those of adjacent pseudopaxillæ are nearly in contact, giving the surface an even and somewhat tessellated appearance. The pseudopaxillæ on the sides of the rays form regular oblique rows, diverging downward and outward.

The papulæ are large and occur either singly or in groups of two or three in each small interspace between the dorsal plates of the disk and arms; on the sides of the arms they mostly occur singly. No papulæ were found below the marginal plates. Madreporic plate of moderate size, covered with fine, much convoluted gyri. Upper marginal plates small, bearing pseudopaxillæ slightly larger than those above them on the basal part of the arms, but becoming much more distinct toward the tips, where the adjacent lateral pseudopaxillæ are small. The inferior marginal plates are much larger and somewhat prominent; the elevated portion is compressed, elongated transversely to the ray, and bears an oblong group of numerous small, crowded paxilliform spinules, similar to those of the dorsal pseudopaxillæ. About 55 lower marginal plates occur on each side of a ray.

The inferior interradial spaces are of rather small size and are closely covered by plates which bear mostly elliptical or oblong paxilliform clusters of small, slender, crowded spinules, similar to those of the marginal plates, but larger than those of the dorsal pseudopaxillæ.

A row of 6 or 8 interradial plates, bearing paxillæ, extends a short distance out on the arms between the marginal and adambulacral plates.

The adambulacral spines are long and slender; in the furrow-series each plate bears a group of 4 (sometimes alternately 3 and 4, or 5 and 4) rather long, tapering subacute, somewhat divergent and nearly equal spines, which stand in a line slightly oblique to the edge of the furrow and are connected together by a web, often extending to half their length in dry specimens and further in alcoholic ones. In alcoholic specimens all the spines are invested in a rather thick membrane. Each adambulacral plate bears, also, a transverse series of 4 or 5 spines of about the same length as, but somewhat thicker than, the furrow-series; they differ but little in length, but the outermost ones are slightly smaller than the inner ones.

The jaw-plates are large and broad; each pair jointly bears an inwardly directed group of 6 rather stout tapered spines, of which the 4 central ones are largest; each plate also bears a marginal row consisting of 7 or 8 somewhat smaller spines, the innermost ones being the largest; a curved row of 8 or 9 similar spines is borne on the central crest of each jaw plate; those of the 2 rows usually cross each other over the elliptical, naked, intermediate space.

Off Cape Cod, station 264, in 80 fathoms, 1879; off Nova Scotia, stations 85 and 86, 101 fathoms, 1877; also taken by the Gloucester fishermen on George's and Western Banks, in 45 to 80 fathoms.

This species is allied to *S. endeca*, but differs widely from that species

in the much longer and more numerous furrow-spines; in the larger and more evenly spined dorsal pseudopaxillæ; in the much smaller and more spinulated ventral areas; and in the shorter and broader jaw-plates and shorter mouth-spines.

SOLASTER BENEDICTI, new species.

Rays usually nine, moderately long, well-rounded, tapering rapidly to the narrow acute tip; rather high at base; in length about equal to the diameter of the disk; the lesser to the greater radii are as 1 to 2.75. Greatest diameter of the largest type specimen, 220 mm.; lesser radius 38-42 mm.; greater radius, 105-115 mm.; breadth of arms at base, 25 mm.; height of arms at base, 15 mm.; diameter of dorsal paxillæ, about 5 mm.; diameter of madreporic plate, 3 mm.; distance from the center of the madreporic plate to anus, 11 mm.; length of the crests of the marginal plates transversely, 3 mm.; height, including spinules, about 2 mm. Jaws broad, truncated, with four subequal oral spines and numerous small lateral spines.

The disk is thick, swollen, usually convex. The whole dorsal and lateral surfaces of the disk and arms are covered with small, well separated, conical pseudopaxillæ which bear a small group of tapering, acute, divergent spinules. The pseudopaxillæ on the central region of the disk are larger than elsewhere and bear about 5 to 7 spinules, of which 1 is central and sometimes longer than the others.

On the sides and towards the ends of the arms the pseudopaxillæ decrease regularly in size until they bear but one or two small spinules near the tips of the arms. On the sides of the arms they are arranged in quincunx and form regular oblique rows. On the dorsal surface they are arranged regularly, but do not form very distinct rows. The papulæ are rather small and mostly occur singly in each interspace between the plates, which are rather firm and form a closely reticulated skeleton. The madreporic plate is small, inconspicuous, partially concealed by several special pseudopaxillæ larger than the rest; it is situated decidedly nearer to the center than to the margin. Anal opening conspicuous, nearly central. The upper marginal plates are very small and bear pseudopaxillæ similar to, and only slightly larger than, those of the plates above them. Inferior marginal plates much larger, with a prominent, much compressed, transverse crest which bears a row of small conical spinules, of which there are 10 to 12 or more on the plates near the base of the arms, where they mostly form a single row, but on the distal portion of the arm, where the plates become thicker and more rounded, the spinules are shorter, stouter, and form two rows; the spinules near the lower margin of the plate are the longest; when well preserved these spinules usually taper to an acute tip. In the interradial angles the crests of the marginal plates become very thin, and the spinules are more slender, more numerous, and often form a single regular row. The actinal interradial areas are moderately

wide and closely covered with concealed plates, each of which bears, on a small conical elevation, one or two tapering acute spines, similar to, but smaller than, the adjacent adambulacral spines. A row of intermediate actinal plates extends out on the rays nearly to the tips, between the lateral and adambulacral plates; each of these usually bears a simple acute spine similar to the adjacent adambulacral spines. In younger specimens a similar row of plates and spines extends out a short distance along the ray. Each of the adambulacral plates bears an inner or furrow-group of 4 or 5 moderately long, rather stout, tapered, acute spines, of which the central ones are a little the longest; these spines are firmly united by a web for more than half their length in dry specimens, in some of which they closely interlock across the grooves. Each plate also bears a transverse row, usually of 3 moderately stout, much tapered, acute, usually somewhat curved spines. These are about equal in length and are longer than, and about twice as thick as, the furrow-spines.

This species was taken in 1885 at station 2530, off George's Bank, in 956 fathoms, one specimen (No. 14848, U. S. N. M.); at station 2550, off Martha's Vineyard, in 1,081 fathoms, one specimen (No. 11816, U. S. N. M.), and in 1886 at station 2682, off Martha's Vineyard, in 1,004 fathoms, three specimens.

CROSSASTER HELIANTHUS, new species.

Rays about 13, rather short, their length less than the diameter of the disk, rounded above, rapidly tapered. The proportion of the radii of the type specimen is as 1 to 2.10.

The greatest diameter is 125 mm.; the lesser radius, 30 mm.; the greater radius, 63 mm.; the diameter of the madreporic plate, 4 mm.; breadth of rays at base, 13 mm.; length of rays, 30 to 38 mm. The disk is large and swollen. The whole dorsal surface is covered with moderately large and somewhat elongated paxilliform prominences or pseudopaxillæ, which are rather regularly arranged and well separated, plainly showing in dry specimens the rather firm and closely reticulated skeleton and the small but well-defined interspaces, so that the surface has a rough appearance when dry. The skeleton plates are stoutest opposite the interradial angles on the disk. The pseudopaxillæ are the broad-based somewhat conical central summits of the plates; each of the larger ones bears a compact fascicle of 6 to 12 or more small somewhat elongated erect spinules, of which 2 or 3 in the middle of each group are a little the longest, causing the clusters to have a rounded apex. Toward the end of the arms the clusters of spinules are much smaller. The papulæ are small and very numerous, 6 to 9 usually occurring in each of the larger dorsal interspaces. Madreporic plate rather large, situated about midway between the center and margin, not surrounded by specially large pseudopaxillæ.

The inferior marginal plates are prominent, well spaced, not very numerous, about 16 to 18 in the type specimen. Those near the base

of the ray are transversely oblong, with a curved summit, and bear 20 to 30 small slender spinules mostly arranged in 2 rows; the upper ones are smallest and similar to those of the dorsal pseudopaxillæ. Beyond the middle of the ray the marginal plates become short and bear an irregular group of crowded paxillary spinules. The upper marginal plates are small and bear paxilliform groups scarcely different from those of the dorsal surface of the rays; on most of the rays there is an irregular row of small pseudopaxillæ just below the inferior marginal plates, but usually terminating before reaching the end of the ray.

Actinal interradial spaces narrow, elongated, and covered with a thick skin which is radially striated and bears small scattered fascicles of 2 to 6 rather long, slender, paxillary spinules, while some similar spinules stand singly, leaving much of the surface bare. The adambulacral plates are crowded and each bears a furrow-group of 3 or 4 rather long, tapering, acute spinules, which stand in a somewhat curved row, the central one being larger and somewhat farther inward than the others; outside of these, each plate bears a transverse row of about 10 to 12 closely placed spines, similar in size to the furrow-spines; some of these spines are forked at the tip, others are obtuse, but most are acute, and the outermost are somewhat smaller and more slender than the others. In alcoholic specimens these spines, as well as all the furrow-spines, are united by a web. The jaw-plates are narrow and elongated; each bears 4 large, inwardly directed terminal spines, of which the 2 central are decidedly larger and longer than the others, and also a row of smaller acute spines on each side. The ventral surface of each jaw forms a sharp, elongated carina inclosing a narrow elliptical space. On each carina there are about 10 to 12 slender elongated spines.

This species appears to be a true *Crossaster*, but differs widely from *C. papposus* in the stouter and closer skeleton plates, smaller and more numerous dorsal pseudopaxillæ, with much shorter spinules, and in the much more numerous and shorter adambulacral spines.

It was taken in 1880 by the Gloucester fishermen, near George's Bank, in deep water (schooner *Martha C. Young*.)

Family PTERASTERIDÆ, Perrier.

PTERASTER (TEMNASTER) HEXACTIS, new species.

Disk broad, very high, evenly convex, with a rather large central opening surrounded by circles of prominent, imbricated, and webbed spines. Rays six, short, broad, tapered to blunt tips, their lateral margins convex. Lesser to greater radii, about as 1 to 1.5. Lesser radii, 22 mm.; greater radii, 32 to 35 mm., in the alcoholic specimen; height of disk, 30 mm.

The surface of the disk is covered with very numerous small spinules, covered more or less completely with a thick skin-like membrane and arranged in irregular, divergent groups.

The integument between the spinules is thick, smooth, firm, and everywhere perforated by numerous very small, round pores.

In each interradial region there is a narrow, radiating groove, lined with thick naked integument, destitute both of spinules and pores, but showing a wrinkled surface. These grooves commence at about one-fourth the distance from the dorsal center to the margin. In some cases there is only a small slit-like opening in the upper end of the groove, communicating with the space beneath the dorsal membrane, but in some of the interradia the slit is much larger and longer, reaching nearly or quite to the margin, and communicates with a large marsupial pouch, containing well-formed young, some of which were in the act of escaping when preserved. Apparently the slit-like openings are formed, or at least much enlarged, when the young are ready to come forth, and after their birth the edges of the slits may become again united.

The dorsal spines or pseudopaxillæ beneath the integument are large, stout, rather long, and surmounted with a large divergent group of long, slender spinules. In the interradial region, within the marsupial pouch, there is a group of several lobed or branched papulæ at the base of each paxilliform spine. The large spines situated along each side, within these cavities, have rudimentary spinules at the summit, which do not reach the outer membrane so that they stand free within the cavity, thus leaving the membrane unsupported along the slits. On the ventral side the rays are nearly flat, and the disk around the mouth is deeply concave.

Each ray is broadest at the margin of the disk. The transverse combs are numerous and covered with a thick, firm skin, which entirely conceals the spines in alcoholic specimens. On the broadest part of the ray, opposite the margin of the disk, there are mostly four, rarely five, spines of moderate length in each comb; of these the one next the groove is somewhat shorter than the two or three which succeed it, while the outermost is still shorter and directed more outward, so that the group has a somewhat rounded, but not very elevated, scalloped margin, the membrane receding somewhat between the points of the spines. The spines, when exposed, are rather slender, flattened, rough, and truncate at the flat tip; beyond the outer spine the web rapidly becomes less elevated and each comb lies somewhat obliquely over the one next beyond it, and becomes only a slightly elevated broad fold before reaching the margin. These folds entirely conceal the transverse, ventral spines, which extend to the margin of the ray, but project beyond it very little, if at all, so that the margin is only crenulate or separated into small blunt lobes, separated by slight notches.

Between the outer ends of the combs of webbed spines there is a small, oval pore, which is sometimes covered by an oval operculum, but in some cases it gives exit to a group of two or three short, blunt papuliform organs.

The jaws are surrounded by a marginal group of long, slender, webbed spines, of which there are about four or five on each side; the two innermost are somewhat the largest; on the actinal side of the jaws there are also two much larger, isolated spines, one on each plate; these are entirely covered by a thick skin; when this is removed the spine is flattened, tapered, and blunt at the tip, with a rough surface, but not hyaline.

The ambulacral feet are large and in two regular rows.

Color of the alcoholic specimen dull purple above, darkest on the central part of the disk and interradial region; beneath yellowish.

Taken at station 2433, off Newfoundland Bank, N. lat. $43^{\circ} 05'$, W. long. $50^{\circ} 43'$, in 57 fathoms; one specimen (No. 12004, U. S. N. M.).

This species not only differs from other known forms in having six rays, but appears to be peculiar in the presence of naked interradial grooves and genital slits. This last character may be sufficient to warrant its separation as a distinct subgenus (*Temnaster*, Verrill), or even as a genus. It differs from our other species also in having fewer and stouter spines in the ventral combs; in the broader and flatter ventral surface of the shorter rays; in the much thicker skin of the ventral combs, and in the less evident comb of spines along the margins of the rays. The dorsal membrane is also firmer and not at all granular; the spinules over its surface are much more numerous, and the pores between them are smaller and more numerous.

The several young ones taken from the interradial slits all have six rays, rendering it probable that this is the normal number.

HYMENASTER MODESTUS. Verrill.

Hymenaster modestus, VERRILL, Amer. Journ. Science, XXIX, p. 151, 1885.

Body small, pentagonal, with concave borders, rays short, broad, subacute. The dorsal membrane is thin, translucent, with minute granule-like specks; the spiracular pores are few and minute; the dorsal cavity, beneath the membrane, is relatively large. Each adambulacral plate bears three very slender, acute, rough spines; two are placed obliquely at the inner edge, and of these the distal is usually much shorter than the other; the third, which is external to the others, but close to them, on the actinal side of the plate, is more erect, longer, and slightly larger; on the middle part of the rays there are often two similar spines on the actinal side of the plate, close together.

The actinal radial spines are very slender, not crowded, 16 to 18 on each side; the longest ones are the fifth and sixth; these and those beyond reach the margin, which is scalloped between them. The pores between the inner ends of the actinal rays are round, and protected by an opercular spine or papilla, which is flat and expanded at the base, but thin and slender at the tip. The dorsal pseudopaxillæ are rather large and few in number, with long terminal spinelets, which project through the dorsal membrane as small spinelets; they are pretty uniformly distributed, and there are no defined radial areas.

The jaws have a salient inner angle and an elevated actinal prominence, on which there is, on each plate, a small, short spine near the inner end (others may have existed, but, if so, were rubbed off in the dredge); on each side of the jaw there is a marginal series of about five slender spines.

Color, in alcohol, pale buff above, pink beneath.

Greater radius, 10 mm.; lesser radius, 7 mm.

Stations 2052 and 2096, in 1,098 and 1,451 fathoms, 1883.

Family ECHINASTERIDÆ, Verrill.

CRIBRELLA PECTINATA, new species

Rays five, elongated, rounded, thick at base, tapering evenly to the small tips. Disk moderately swollen, the lesser to the greater radii as 1:4.4.

The lesser radius of the type-specimen is 15 mm.; the greater radius, 66 mm.; breadth of rays at base, 18 mm.; diameter of madreporic plate, 3 mm.

The whole dorsal surface and sides of the rays are evenly covered with small well-spaced pseudopaxillæ, each of which bears a fascicle, or more rarely a comb-shaped group of four to eight or more small slender spinules, which stand nearly erect, and are nearly equal in length. The pseudopaxillæ arise from elevations of the plates and are so spaced as to leave intervals greater than their own diameters, thus giving the surface a rough papillose appearance; the pseudopaxillæ are more closely arranged on the center of the disk than on the arms. The madreporic plate is large and covered with rough spinules in comb-like groups.

Each of the interspaces on the arms bears a single large papula, equal in diameter to or exceeding the pseudopaxillæ; similar papulæ occur between the ventral plates, where they form regular longitudinal rows. On the ventral surface of the rays there are three regular longitudinal series of plates corresponding in number to the adambulacral plates. The plates in the two outermost rows are oblong at the summit, and each bears an oblong group of slender paxilliform spinules, arranged in two rows, and similar to those of the back. The plates of the outer row are somewhat smaller than those of the next, and the spinules are about twelve to fifteen in number toward the base of the rays, while in the next series there are from twenty to twenty-five spinules, which form pretty regular comb-like groups; these extend to the tips of the arms. Each of the interspaces between these rows of plates (which probably represent marginal plates) contains a single large papula. Closely adjacent to the adambulacral plates there is a row of smaller plates, each of which bears a round group of small paxilliform spinules, ten to fifteen in number, similar in size and form to those of the marginal plates. This row of intermediate plates extends from the angle of

the jaw nearly to the tips of the arms, and is not separated from the adambulacral plates, with which they correspond in number, by any papule.

Each of the adambulacral plates bears a single small spine, situated deep within and directly across the furrow, forming a single longitudinal series, and also a transverse group, consisting of eight to twelve round, blunt spinules, in two rows; the three inner ones are decidedly longer and larger than the rest, the innermost odd one being the largest of the three, and standing erect on the extreme inner angle of the plate, and therefore nearly at right angles to the small spine within the furrow. The outermost spinules of these groups are similar in size to those of the adjacent ventral plates, from which they are separated by a distinct continuous groove. The jaws are covered with numerous erect spines, which are similar in size and form to those of the adambulacral plates, but the adambulacral plate nearest the mouth bears a group of small blunt spinules deep within the furrow.

Eastport, Me., in shallow water, 1870. (A. E. Verrill.)

This species is similar to *C. sanguinolenta* in form and general appearance, though the dorsal surface is more uneven and papillose, owing to the larger size of the pseudopaxillæ and the more regular interspaces; the pseudopaxillæ are generally more in the form of rounded fascicles, instead of regular comb-like groups. The differences are much more marked on the ventral surfaces, where the three regular rows of larger ventral plates give a very different appearance to this region, for in the former species the plates are scarcely distinguishable in size, form, and spinulation from those of the lateral and dorsal plates of the rays. The adambulacral and jaw-spines are also shorter and more crowded than in the common form; the papule are more regularly arranged and not so numerous.

Family ASTERIIDÆ, Gray, 1840 (emended).

HYDRASTERIAS OPHIDIION, Sladen.

Asterias (Hydrasterias) ophidiion, SLADEN, Voyage of the Challenger, xxx, p. 581, pl. 99, figs. 3 and 4; pl. 103, figs. 3 and 4, 1889.

A broken specimen was found at station 2573, in 1,742 fathoms. Its structural characters appear to me to be worthy of generic rank.

Family BRISINGIDÆ, Sars.

ODINIA AMERICANA, Verrill.

Brisinga americana, VERRILL, Amer. Journ. Sci., xix, p. 139, 1880; Rep. Com'r. Fish and Fisheries, xi, p. 636, pl. 17, fig. 52, 1885.

Freyella americana, SLADEN, Voyage of the Challenger, xxx, pp. 616, 617, 834, 1889.

This large species is furnished with an abundance of long papule on the swollen genital region of the rays, as stated in the original description. It belongs, therefore, to the genus *Odinia*. It is not easy to un-

derstand why Sladen should have referred it to *Freyella*, unless by inadvertence.

BRISINGA COSTATA, Verrill.

Brisinga costata, VERRILL, Amer. Journ. Sci., xxviii, p. 382, 1884.

The original type from station 2210, in 991 fathoms, has the following characters:

The disk is firm, round, roughly spinulose, the spines small, sharp, standing singly or in groups of two, three, or more. Interradial plates nearly concealed, the exposed part verruciform. Madreporic plate moderate, with many radiating gyri. Arms very long, strongly depressed, somewhat swollen toward the base, but broad and angular and carinated farther out, gradually tapering. The basal portion is crossed by 20 to 25 curved or sinuous, very prominent, strong, narrow ribs, or carinæ, some continuous and some interrupted, and surmounted by a simple row of small, short, acute spinules. Smaller transverse raised bands of pedicellariæ and small spinules alternate with the ribs. The adambulacral plates bear usually three, or alternately two and three, slender, fluted, glassy spines in a transverse row at about the middle of the plate. The two actinal ones are longer and larger than the other, which is small, nearly erect, and situated on the proximal angle. In addition to these there is a smaller, more slender, inner furrow-spine, situated at the distal end of each plate and projecting horizontally more than half-way across the groove. Sometimes on alternate plates there are two of these transverse spines toward the base of the arms. The outermost large spine on alternate segments stands raised on a tubercle on a separate lateral plate, which appears to become consolidated with the adambulacral plate on the distal half of the ray. The alternate lateral plates are elongated, radially narrow-oblong, spineless, and in contact with the adambulacral plates. These lateral plates agree nearly with the adambulacral in number, but not in length. All the spines are sharp and bear swollen sheaths covered with minute pedicellariæ.

The jaws bear, on each half, a slender transverse spine on the inner angle and a large one on the outer angle; sometimes the two outer ones are consolidated into a single larger median one. The adoral end is often without spines, but sometimes bears one small spine on each half or one on one side directed orally. The lips close to the mouth are slightly verrucose.

Diameter of disk, 28 mm.; breadth of arms, near base, 11 mm.; length of longest spines, 12 mm.

Station 2210, in 991 fathoms (No. 7820, U. S. N. M.). It was also taken at station 2533, in 828 fathoms, and at station 2734, in 841 fathoms, a single specimen at each locality.

BRISINGA MULTICOSTATA, new species.

Rays 15 in the type specimen. Disk 27 mm. in diameter when dried; round, flat, densely covered with small, rounded, convex plates,

which are in contact or somewhat imbricated over the greater part of the surface and have a small conical elevation in the middle, upon which there is generally 1, but sometimes 2 or 3, small, slender, very acute spines of nearly uniform size over the entire surface, except at the origin of the rays, where both plates and spines are smaller. The madreporic plate is small, situated close to the margin, and has prominent radiating gyri.

Between the bases of all the arms and standing obliquely on the margin there is a rather large, oval, interradiial plate, with the surface concave and bare of spines, except around the margin, which is more or less encroached upon by small spinous disk-plates. On the central part of each interradiial plate there is a small group of pedicellariæ having very slender, curved jaws. A few similar pedicellariæ occur scattered on the disk between the spines. Opposite the base of each ray, near the margin of the disk, there is a pair of small pores each in the middle of a small naked membrane.

The jaw-plates are narrow and elongated, the two together being somewhat hour-glass shaped. Each jaw usually bears a pair of very slender, sharp spines on the oral edge, directed inward; sometimes there is also a much larger median spine in the same plane; on the extreme inner angle on each side there is also a very small, slender spine directed transversely, but the relative size and even the number of these spines varies on the different jaws of the same specimen; on the outer end each jaw bears a pair of much larger lateral spines which stand more erect; sometimes an additional smaller spine occurs just below one or both of these. On some of the jaws an additional large lateral spine is occasionally found at about the middle and near the margin of one plate and occasionally a pair of such spines appears. All the jaw-spines are covered with groups and clusters of pedicellariæ, and the larger spines are inclosed in a sacculated membrane.

The rays are very long, rather large; in the basal-genital region the ray is somewhat swollen and evenly convex, but is here broader than high in the dry specimen; farther out the rays gradually become slender and angular, with a strong dorsal carina due to the ambulacral plates beneath the thin membranous integument. The genital region is usually prolonged and is crossed by a very large number of considerably elevated, thin, acute, transverse ribs or carinæ, composed of conical and oblong elevated plates, and surmounted by a simple row of numerous very slender, sharp spines, mostly arranged in comb-like groups along the crest of the plates. In a well-grown specimen there are on some of the rays upwards of 60 transverse ridges, besides a number of irregular ones at the proximal and distal portion. The ridges, however, are not very regular, many of them being crooked and more or less interrupted, while a very few extend entirely across the ray, and the number varies considerably on different rays. Where best developed these ribs are alternately larger and smaller; the larger ones cor-

respond with and are opposite to the adambulacral plates and have a large lateral spine at their origin on each side; the smaller ribs are irregularly interpolated between the larger, but have the same kind of plates and spinules, but have no large lateral spines; close to the base of the ray the plates are often irregularly scattered on the dorsal surface and form imperfect rows only on the sides. The number and closeness of the transverse ribs varies on different arms of the same specimen, but in all cases they are more numerous (45 to 60) and closer together than is usual in the genus. A series of round brownish spots, alternating with the larger transverse ribs on each side, apparently indicate the position of the genital pores.

In contact with the adambulacral plates there is a row of small, alternately unequal, lateral plates, two of them corresponding to each adambulacral plate. Toward the base of the rays these plates are about as broad as long, but distally they become narrower and more oblong and much smaller. On the tumid part of the ray, except close to the base, those lateral plates nearly opposite the middle of the adambulacral plates are elevated, and have a central tubercle, bearing a long, slender, strongly fluted, acute spine similar to the outer ones of the adambulacral plates; toward the extreme basal part of the ray these lateral spines decrease in size, until on the first 4 or 5 segments they are nearly abortive. The long lateral spines continue on the distal part of the ray, but the lateral plates which bear them often become consolidated with the adambulacral plates. The alternate lateral plates are flat and bear no spines.

The adambulacral plates are numerous and short, excavated at the middle of the inner margin. On the middle of the swollen reproductive region each plate may bear as many as 5 or 6 spines; of these, 2, forming the transverse furrow-series, are very slender and situated 1 at either end of the inner margin of the plate extending more than half way across the furrow; another slender spine of similar size often stands above each of these, but one or both of these may be absent, on alternate plates, especially on the more distal part of the ray. On the actinal side, and at about the middle of each plate, there are 2 much larger and longer spines, one external to the other, the outer one being considerably larger and longer than the inner, its length being equal to the breadth of the ray; these two, with the similar lateral ones, form an oblique transverse row. Close to the basal part of the ray, the two outermost of the adambulacral spines become much stouter and are columnar in form; the tip becomes swollen with a truncate or convex papillose summit. The apical papillæ apparently correspond to the terminations of the lateral flutings.

The transverse spines within the furrows bear, sometimes singly and some times in clusters, more or less numerous rather large pedicellariæ with very slender, strongly curved jaws. Similar pedicellariæ occur between the larger spines on the adambulacral plates. The larger

spines, in alcoholic specimens, are covered with a loose sacculated integument, which is densely covered with minute, crossed pedicellariæ. The ambulacral feet are large with well developed terminal suckers; each one is usually separated from the next in the same row by two transverse furrow-spines, but frequently only one of these is developed.

A good sized specimen in alcohol has the radius of the disk, 14 mm.; length of the longest remaining ray, which is broken at some distance from end, 220 mm.; breadth of the rays at base, 6 mm.; at the widest part, 8 mm.; length of the disk-spines, 1 to 1.5 mm.; length of longest arm-spines, 14 mm.

Taken in 1885, at station 2573, off George's Bank, in 1,742 fathoms, 3 specimens (No. 12074, U. S. N. M.); also in 1886, at station 2685, off Martha's Vineyard, in 1,137 fathoms, 1 specimen (No. 14858, U. S. N. M.).

BRISINGA VERTICILLATA, Sladen.

Brisinga verticillata, SLADEN, Voyage of the Challenger, xxx, p. 604, pl. 109, figs. 9-11, 1889.

A number of disks and loose arms have been taken off our coast, from N. lat. 41° 13', W. long. 66° 50'', to N. lat. 36° 34', W. long. 73° 48', in 906 to 1,374 fathoms.

FREYELLA ELEGANS (Verrill) Sladen.

Brisinga elegans, VERRILL, Amer. Journ. Science, xxviii, p. 382, 1884.

Freyella bractiata, SLADEN, Voyage of the Challenger, xxx, p. 629, pl. 114, figs. 1-4, 1889.

Rays nine to fourteen, but in the majority of specimens twelve, very long and slender, with the reproductive region considerably prolonged and only slightly swollen. Radii as 1 to 36+. Diameter of the disk of a large specimen, about 25 mm. Disk small with rather acute interradial notches. The surface is densely covered with small, unequal, somewhat imbricated plates, most of which are rounded in outline, while others are angular; all have an elevated, conical, central tubercle, and bear from one to three, or four, small sharp spines, much the greater number having only one spine. Madreporic plate close to the margin, prominent, with few deep grooves separated by broad ridges. Interradial plates not distinct, dorsal pore nearly central, usually very distinct and surrounded by a group of small spinules, borne on small angular plates somewhat smaller than those on the rest of the disk. The spinules of the disk are numerous and uniform in size, so that it appears to the naked eye rather closely and evenly spinulated. Numerous small, delicate pedicellariæ are usually scattered over the disk between the spines and around their bases, but in some specimens these are mostly wanting. The peristome is very large and the buccal membrane is smooth and delicate. The jaws are rather narrow, longer than broad, with prominent inner and outer angles with incurved sides and a distinct median suture; each half bears two transversely directed spines, one at the extreme inner and the other at the outer angle of the furrow;

the inner end usually bears also a pair of very slender, acute spines directed orally, one on each plate, but sometimes some of the jaws have three or four inner spines, and sometimes but one, in the same specimen; each half of the jaws also bears a much larger and longer spine on the actinal surface at the extreme outer end, corresponding in size and position with the adjacent adambulacral spines. All the mouth-spines are covered with membranous sheaths, often saeculated, and bearing large numbers of minute pedicellariæ, among which are some of much larger size with strongly curved jaws.

The slightly tumid genital region of the rays extends about one-fourth the total length; this portion is evenly rounded on the upper surface and densely covered with angular imbricated scales, each of which usually bears a transverse group of small, sharp spinules, similar to those on the disk (the number varies from one or two to six or eight); they frequently form comb-like clusters on the sides of the arms, where they are most numerous. In some of the larger specimens some of the large plates on the sides of the arms bear, here and there, a single spine three or four times as large as usual. Beyond the genital region the ray is somewhat triangular, with a strong bilobed dorsal carina due to the ambulacral plates showing through the thin dorsal membrane. The rays taper very gradually to a long attenuated distal portion. The carinated portion of the ray is crossed by broad bands of minute pedicellariæ corresponding with each adambulacral plate. The ray terminates with a rather conspicuous plate at least twice as wide as the ray near it; seen from above it has an obovate form swollen in the middle and bilobed on the proximal end; on the rounded aboral end there are six long, slender spines, of which the two median ones are smallest and the lateral ones as long as, or longer than, the length of the plate; at the extreme outer end of the plate there is a projection beneath which the eye is situated.

The adambulacral plates are numerous, rather short, and narrow; the furrow side is strongly concave in the middle opposite the suckers, and the distal angle is narrow and prolonged so as to touch or slightly overlap the proximal angle of the succeeding plate. The sutures between the plates are rather wide and moderately oblique. Toward the base of the rays, in the larger specimens, each plate usually bears a single, long, transverse spine on its distal angle; these spines, extending more than half across the groove and overlapping the spine of the opposite side, serve to separate the pairs of suckers. Along the thickest part of the ray some of these plates have two similar transverse spines, one just above the other, but the extra spine seldom occurs on the smaller specimens. On the prominent actinal surface each plate bears a much larger, long, slender, acute, strongly fluted spine; back of this there is another row of similar large spines one-half as numerous, which often appear to stand on the outer distal angle of the adambulacral plate, but on certain parts of the ray the small

plate which bears them is distinct, and may be recognized to belong to a separate series of small lateral plates which lie in contact with the outer edge of the adambulacral plates and between which there are, alternately, one or two small plates without spines; close to the base of the rays these lateral spines are entirely obsolete. On the distal half of the ray the plate bearing the lateral spines is usually consolidated with the distal end of the adambulacral plate. Owing to this arrangement the adambulacral plates appear to bear, alternately, one or two long actinal spines on prominent basal tubercles. The longer spines on the distal part of the rays are often as long as three or four adjacent arm-segments; on the basal part they are usually equal to about two arm-segments. All the large spines are covered with sacculated integument which is completely covered with minute pedicellariæ. The furrow-spines bear clusters of somewhat larger pedicellariæ near their tips.

A rather large, dry specimen has the radius of the disk, 12 mm.; length of the longest ray, which is broken at the end, 200 mm.; breadth of ray at base, 5 mm.; at the widest portion, 7 mm.; height, 7 mm.; length of dorsal spines, about 1 mm. Another dry specimen has the radius of the disk, 9 mm.; length of the longest ray, which is broken at some distance from the end, 175 mm.; greatest breadth of ray, 5 mm.; length of the longest spines, 6 to 7 mm.

Taken at several stations in 1,374 to 1,434 fathoms.

FREYELLA ASPERA, new species.

Rays, thirteen. Diameter of the disk, when dried, 20 mm. The dorsal surface of the disk is covered with rather large, irregular, often rounded, somewhat thickened plates, which are imbricated on the central portion of the disk, but separated more or less by naked integument toward the margin, and imbricated immediately around the margin. Each plate bears a group of rather stout, conical, acute, divergent spines about 15 to 20 mm. long; they often form somewhat stellate groups, but in other cases stand in one or two transverse rows. Each plate usually bears from three to eight spines and also some rather large crossed pedicellariæ, with slender, strongly curved jaws. The dorsal pore is subcentral and surrounded by a group of spines a little larger than those over the rest of the disk. Madreporic plate, small, prominent, with a few rather wide, deep, convoluted grooves.

The jaws are short and wide, about as broad as long, with prominent inner angles and somewhat incurved lateral margins. Each jaw normally bears six spines at the adoral end; usually there are four of these, arising from the inner edge and directed inward, which are small, rather slender, and subequal, their length being equal to about one-half the width of the jaw; each inner angle bears a larger, rather short, robust spine, which projects obliquely about half way across the furrow; each outer angle bears a rather long robust spine on the actinal surface;

on some of the jaws there is a similar spine on the middle of each lateral margin, but these are more frequently absent. Some of the jaws also vary in the same specimen by having only two small spines on the inner edge; others have three.

All the jaw-spines are covered with loose membrane, which bears clusters of numerous pedicellariæ, those on the longer actinal spines being very minute, while those on the oral spines are much larger, with slender, strongly curved jaws.

All the arms are broken off in our type specimen, only the three basal segments remaining on any of them; on these segments each adambulacral plate bears a slender, transverse furrow-spine on the prominent distal angle of the margin, and a rather long, slender, acute, fluted spine on its actinal surface; the latter are covered with minute pedicellariæ, while the transverse furrow-spines carry clusters of large pedicellariæ like those of the oral spines.

The dorsal plates of the bases of the arms, so far as preserved, are similar to those of the disk, but rather smaller, and carry similar, but smaller, spines in small groups.

Taken in 1883 at station 2097, off Chesapeake Bay, in 1,917 fathoms (No. 6301, U. S. N. M.).

This species resembles the coarser spined variety of *Brisinga multi-costata* in the spinulation of the disk, but the jaws are much broader and their spines quite different.

FREYELLA MICROSPINA, new species.

Rays in the type specimen, thirteen, slender, and of moderate length, evenly rounded and a little swollen on the genital region, angular and slender beyond. Radii, about as 1 to 10. Dorsal surface of the disk is thickly covered with small, rounded plates, each of which bears a cluster of numerous very minute spinules in more or less stellate groups, mostly of six to twelve. Interradial plates indistinct or showing but little of the surface. Jaws very short and broad, the breadth about equal to the length; the oral end usually bears six small divergent spines, three on each half, but sometimes only four or five are developed; of these the two outermost, situated on the angles, are directed nearly transversely and are usually blunt or bilobed at the end; the other four, which are directed orally, are smaller, the two central ones very small and papilliform. The actinal surface of the jaw usually bears a pair of rather short, robust spines situated on the somewhat prominent outer angles; these spines are more or less clavate and often flattened at the end, which is usually divided into two to four short prongs or papillæ, and in some cases it is deeply fissured; they agree nearly in size and structure with the succeeding spines on several of the basal adambulacral plates.

The genital region of the ray occupies rather more than one-fourth the total length, and is considerably swollen on the upper side, so that

the height, where best developed, is greater than the breadth. The dorsal surface of this portion is completely covered by flat, imbricated, rounded, and angular plates, each of which bears a large number of very minute, sharp, conical spinules, which are closely arranged over most of the surface, but on the sides of the rays they often form two or three small transverse rows on each plate. With these spinules on the plates there are also many minute pedicellariæ.

Low down on the sides of the rays, and especially on the distal portion of the genital region, the plates form regular transverse series or bands with naked integument between them; each of these bands corresponds with one of the adambulacral plates. The last of the bands are imperfect, or represented by only a few plates on the dorsal surface, and cease entirely opposite about the twenty-fifth adambulacral plate. On the distal part of the arm the thin membrane is crossed by a broad band of minute pedicellariæ, a band corresponding to each adambulacral plate. Apical plate not much enlarged, short, obovate, obliquely truncate at the end, about as long as broad; its spines have been rubbed off from the only one preserved.

Along each side of the ray there is a row of long, slender, lateral spines apparently arising from small tubercular marginal plates, which are mostly coalescent with the outer end of the adambulacral plates and usually might be described as a part of them. These marginal spines, on the distal part of the rays, occur opposite the alternate adambulacral plates, but along the genital region they occur only opposite every third plate.

The adambulacral plates are somewhat longer than broad, except at the base of the ray, and but little emarginate on the furrow-margin. Each plate bears a long, slender, fluted spine on the actinal surface, similar to the adjacent marginal spines, and on alternate plates there is usually a much smaller, acute, more or less inclined furrow-spine standing just in front of the larger one, but these are mostly absent or rudimentary on the distal half of the ray. There are no transverse furrow spines, unless the spines just described be considered as such. On nine or ten of the basal adambulacral plates the large actinal spine is stout and columnar, with swollen or clavate tips, concave on the summit, and bearing about four to eight blunt papillæ around the margin; those nearest the base are shortest and stoutest, the length increasing and the size of the terminal enlargement decreasing gradually on those farther out.

Radius of disk, 10 mm.; of longest rays (which may have been regenerated), 95 mm.; length of longest spines, 8 mm.

Taken in 1884, at station 2220, off Martha's Vineyard, in 1,054 fathoms, one specimen (No. 7821, U. S. N. M.).

This peculiar species, in having a more or less distinctly banded arrangement of the plates on the genital region of the rays, approaches the restricted genus *Brisinga*, but its affinities are decidedly with

Freyella in other respects. The stout, clavate or mushroom-shaped spines at the base of the arms are similar to those of *Brisinga multicostata*, but the end is concave and the papillæ of the terminal crown are fewer and larger. In the absence or rudimentary condition of the transverse furrow-spines it differs from most of our other species, as well as in the minuteness and great number of the dorsal spines of the disk and rays.

OPHIUROIDEA.

Family OPHIURIDÆ.

OPHIOGLYPHA SAURURA, new species.

A five-rayed species with very convex, angular, unequal disk-scales and radial shields, the latter with prominent outer ends nearly or quite in contact. Arms high and somewhat carinate, each dorsal plate with a central and distal prominence, thus appearing serrate in profile. Three short arm spines. Mouth-shield broad, shield-shaped, pointed within. Mouth-papillæ numerous, regular, pointed. Arm-comb absent or rudimentary.

Diameter of the disk, 17 to 18 mm.; length of arms (broken at tip), somewhat more than 40 mm.; breadth of arms at base, 3 mm.; height, 3.5 mm.

Disk flattish, moderately thick, pentagonal, with prominent corners and a small angular notch at the base of the arms. The disk-scales are very irregular in size and form, imbricated and mostly angular, with a prominent central or distal conical or rounded elevation on each.

The primary plates are only slightly larger than many of the others; the central plate is round and easily distinguished. In each interbrachial space there are four or five plates somewhat larger than those on the central part of the disk—one in the center of the margin is the most conspicuous; radial shields irregularly triangular, longer than broad, with the inner ends acute and widely divergent, the outer ends and sides obliquely rounded. The surface at the distal end rises into a conical or rounded prominence. In some cases the distal ends are in contact or slightly overlap one another. The divergent proximal ends are separated by four or five angular plates, of which one or two are large and prominent. The arm-comb appears to be entirely wanting.

Mouth-shields rather large, thick, convex, broad, shield-shaped; length, 3.5 mm.; breadth, 4 mm.; the outer margin is slightly rounded or subtruncate; the outer angles rounded; sides nearly straight, and the proximal edges straight or slightly incurved, forming an obtuse inner angle. The side mouth-shields are elongated, narrow, curved, with the inner ends somewhat spatulate. The interbrachial areas beneath are covered with convex, thick, angular plates similar to those of the back, but more regular; of these there are about twenty-four in each area, besides small ones in the angles between them. Mouth-papillæ are numerous, regular, closely arranged, acute, conical, with two at the angle of the jaw a little longer than the rest.

The genital slits are long and large, bordered along their distal portions by a long conspicuous genital plate. The papillæ are minute and granule-like along the proximal part of the slit, but become larger, flattened, and squarish at the distal end, where they are about two-thirds as long as the upper arm-spines.

The papillæ around the first tentacle pores are a little larger and blunt; of these there are from six to eight to each pore. The second pair of pores have four or five much smaller papillæ on each side. The third and fourth have about four. The next two have about three on each side; then, on about three or four joints, there are about two or three on the inner side; beyond that, only one.

The arms are of moderate length, regularly tapered, angular, higher than broad, with a more or less evident dorsal carina. In the typical specimens the dorsal plates are very much thickened and prominent; each one is crossed by one, or sometimes two, deep transverse grooves, so that the upper surface is divided into two, and sometimes three, elevations, of which the distal one is the most marked and forms the outer margin of the plate; the other one forms a more or less irregular central prominence which at the base of the arms forms a blunt transverse ridge, but farther out it becomes a rounded or ovate elevation of the median portion only. In the largest specimen the prominence at the base of the arms is divided into two by a secondary transverse groove; seen from above the dorsal plates, near the base of the arms, have a more or less regular hexagonal outline. The first seven plates are broader than long; the next six or seven are more regularly hexagonal; farther out they become more and more elongated, until the length becomes nearly double the breadth. The side arm-plates are thick with prominent distal margins. The arm-spines, which are three (rarely four) toward the base of the arms, are small, short, papilliform, nearly equally spaced, though the upper one is often somewhat removed; they are not more than one-fourth as long as the side arm-plates. In one specimen there are regularly four arm-spines on about three arm-joints near the edge of the disk. The first under arm-plate is pretty regularly pentagonal, about as broad as long; the second and third are larger, longer than broad, with the outer end broadest and the outer margin curved; beyond this the plates become broader than long, with the outer margin strongly curved and the sides slightly convergent; beyond the middle of the arm the form becomes transversely elliptical. Beyond the fifth or sixth under arm-plates the lateral plates meet beneath, and they become relatively longer in proportion as they approach the tips of the arms.

Variations.—A specimen from station 2528, of somewhat smaller size, having the diameter of the disk 14 mm., differs slightly from the type specimens. The disk scales are more rounded and evenly convex and the characteristic elevations on the dorsal arm-plates are much less conspicuous, owing to the transverse groove being broad and shallow,

nevertheless the entire margin of each plate rises into a very evident transverse ridge, very much as in the typical specimens. The arm-spines are a little larger and longer, about one-third as long as the side arm-plates near the base of the arms. The mouth-shields are also relatively broader and shorter, though they preserve the same general form. The scales on the ventral interbrachial areas are more numerous, smaller, and more equal, there being about forty of the larger ones.

Station 2429, south of Grand Bank, in 471 fathoms (No. 11500, U. S. N. M.) two specimens; station 2528, off George's Bank, in 677 fathoms (No. 11499, U. S. N. M.), one specimen, 1885.

OPHIOGLYPHA TESSELLATA, new species.

A large species allied to *O. confragosa* Lyman. Disk pentagonal, with small notches at the bases of the arms, and without any distinct arm-comb. Radial shields irregularly ovate, or subtriangular, well separated. The rest of the disk is covered with pavement-like scales, irregular in size and form, among which the primary plates can usually be distinguished. A large plate lies in the center of the interbrachial margin. Mouth-shields pentagonal, bordered distally by another plate nearly as large.

Arm-spines, generally three, papilliform, very small and slender, the upper one widely removed from the others. Tentacles apparently confined to a few of the basal joints of the arms. Arms somewhat thickened at the base, with swollen joints, rounded above and regularly tapered, appearing rather rigid.

The disk is flattened or moderately swollen, with the interradial margins slightly curved or nearly straight. In young specimens, 6 to 8 mm. in diameter, the primary plates form a pretty regular rosette, and the large marginal interradial plates are in contact with the radial shields at each end; the radial shields are separated by a wedge of three plates in a single row.

In the largest specimens, which are about 22 mm. in diameter, with the arms about 65 mm. long, the disk-plates are much more numerous and irregular; the primary plates are rounded, about 1.75 to 2 mm. in diameter, but most of the intervening plates are angular, many of them appearing as if broken, with very small, irregular ones between the larger ones. The disk-plates are slightly thickened, but nearly flat, separated by narrow, rather deep grooves, in which the membrane appears wrinkled. In alcoholic specimens, the disk-scales are more or less obscured by a thin skin. The radial shields are about 4 mm. long and nearly as broad; their inner ends are divergent and form a somewhat acute angle; they are separated by six to eight scales, of which two or three are largest, and by two or three inner dorsal arm-plates. The large median interradial plate occupies most of the margin between the radial shields, but has a small supplementary plate at each end. The interradial area, beneath, is largely occupied by the large trap-

ezoidal or pentagonal plate adjoining the distal end of the mouth-shield, by two large, elongated genital plates, and by a submarginal row of about three or four angular plates, of which one or two, in the middle, are much smaller than the rest.

The mouth-shields are large, pentagonal, rather longer than broad, the length in the larger specimens being about 3.5 mm. and the breadth about 3 mm.; the distal margin is straight, or somewhat incurved; the lateral margins nearly parallel, and the inner edges are nearly straight, meeting nearly at a right angle. The side mouth-shields are narrow and oblong, with nearly parallel sides. The genital papillæ commence at the mouth-shields as a single row of small irregular granules, but become more numerous distally, and at the edge of the disk, near the base of the arms, form an elongated, triangular group of rather large, unequal granules, about twelve to fifteen in number.

The teeth are short, stout, angular, and blunt. The mouth-papillæ, in specimens 10 to 13 mm. in diameter, form a nearly regular close row of six to eight; they are small, short, blunt, flattened, and usually squarish in outline, though some are oblong, and twice as broad as high; toward the distal end of the mouth-slits more or less of the papillæ are often soldered together. In the largest specimens the mouth-papillæ become more irregular and often form two rows, besides a row of granules above them; those of the lower row are stout, blunt, conical, unequal in size; those of the upper series are much smaller, rounded or conical.

The inner tentacle-pores, in the large specimens, are bordered by six or seven short, blunt, squarish scales on each side; the second pair has three or four very small scales on each side; the third, about three minute scales on each side; and the fourth pair has two on the proximal, and one, more minute, on the distal side; beyond the fourth pair of pores, which are minute, no pores are visible, though a distinct pit exists, bordered by a single minute spiniform tentacle-scale on the proximal side, and by the lower arm-spine.

The arm-spines are usually three, very minute, and nearly equal; the uppermost is near the upper distal angle of the side arm-plate and widely separated from the others; the lowest is usually close to, or in contact with, the tentacle scale; the arm-spines are not more than one-fifth or one-sixth the length of the side arm-plates.

The dorsal arm-plates are thickened, but not much swollen, and are separated by rather wide and deep grooves; the two or three basal ones in the notch of the disk are short and small; the first free plate is shorter than broad, somewhat lunate; the plates succeeding this become constantly longer in proportion to their breadth; for a short distance from the base of the arms they are trapezoidal and have a strongly curved outer margin, straight convergent sides, and a narrow incurved proximal margin; beyond the middle of the arm they become triangular or wedge-shaped with the distal margin strongly convex

and the proximal ends forming an acute angle, while the side arm-plates meet more and more between them.

The side arm-plates are large, thick, and prominent, separated by deep furrows; on the ventral side they begin to meet at about the third arm-joint beyond the margin of the disk, and their length increases rapidly until it becomes twice that of the ventral plates near the ends of the arms; on the upper side they begin to meet at about the fourteenth or fifteenth free arm-joint.

In many of the larger specimens the dorsal plates are divided by an irregular median furrow into two parts, and in many specimens they are again irregularly divided into smaller portions by one or two more or less transverse furrows, so that they often appear as if composed of four or five irregular pieces; but in other specimens of similar size the plates are entire.

The first ventral arm-plate consists of two small wedge-shaped pieces between the innermost tentacle-pores; the next is much larger, about as long as broad, a little thickened, somewhat shield-shaped, or pentagonal, with rounded corners; the next is broad triangular, with the outer margin strongly curved and the middle of the lateral margins excavated for the second pair of tentacle-pores, and the inner end narrow and slightly truncated; those following become relatively wider, broad triangular, with a strongly curved outer margin, incurved sides, and more or less acute inner angle; beyond the middle of the arm they become relatively smaller, widely separated, and the inner margin forms a very obtuse angle.

Color, in alcohol, dull grayish or dirty brown.

Variations.—There is considerable variation, even among the adult specimens, while the young, 8 to 10 mm. in diameter, differ in many respects from the large ones. The number and form of the mouth-papillæ and tentacle-scales vary somewhat in specimens of the same size. The mouth-shields are sometimes more top-shaped or pear-shaped than in the specimens described; the lateral margins being convex with the corners rounded. The large plate at the distal end of the mouth-shield is sometimes divided into two or three parts, most frequently by the separation of the two inner corners as small triangular plates. The two lower arm-spines are not always close together, and sometimes four spines occur, the extra spine appearing either just below the upper one or just above the second.

In the young specimens, 8 to 10 mm. in diameter, the scaling of the disk is much more regular, and the relatively large primary plates form a pretty regular rosette. The mouth-shields are relatively shorter and more top-shaped. The mouth-papillæ and tentacle-scales are very regularly arranged and less numerous than in the specimens described. The first complete ventral arm-plate is prominent and rounded; all the ventral plates beyond this are separated by the side arm-plates. The next three or four lateral arm-plates are broadly turbinate, with the

outer border evenly curved, and the lateral margins form an obtuse angle. In some of the young specimens of this size there are four minute arm-spines on the proximal joints, three of them being placed together near the tentacle-scale.

Taken off the eastern coast of the United States at fourteen stations, between lat. $39^{\circ} 35'$ and $41^{\circ} 47'$, in 250 to 1,106 fathoms, most frequently between 400 and 1,000 fathoms. A single specimen was taken off Delaware Bay in 2,033 fathoms, at station 2,038, in 1883.

This species, when first discovered, was referred to *O. confragosa* Lyman, from off Patagonia, Mr. Lyman himself having made this identification after having examined one of our specimens; but the subsequent acquisition of a much larger series leads me to consider the two forms distinct, though closely related. Our form is easily distinguished by the single large plate external to the mouth-shields; by the more regular and more closely arranged disk-scales; by differences in the mouth-papillæ and tentacle-scales, and by the somewhat different form of the under arm-plates. In *O. confragosa* the radial shields are represented as being decidedly smaller and much more widely separated than in our species, while the large plate in the interbrachial margin is also much smaller. In the latter there are generally but three arm-spines, while in the former there are usually four.

OPHIOGLYPHA GRANDIS, new species.

A very large species with a swollen, pentagonal disk, covered with irregular, angular scales and rather small, short, irregular, widely separated radial shields. Arms high, with pentagonal dorsal plates and transversely elliptical ventral plates. Arm-spines three, small, subequal; the upper one considerably separated from the two lower ones. Mouth-shields broad, shield-shaped; about as broad as long. Tentacle scales numerous at the base of the arms.

Disk, in the type specimens, from 23 to 30 mm. in diameter; length of the longest arms, all of which are broken at the tips, more than 90 mm.

The disk is generally considerably swollen and plump, with the interbrachial margin nearly straight, or a little convex, and with only a slight notch at the bases of the arms, where there are usually no distinct arm-combs, but in those few specimens in which they occur they consist of a single row of from six to eight small, flattened, squarish, scale-like papillæ on each side, which decrease in size from below upward.

The central and other primary plates of the disk are distinguishable, but are only slightly larger than the intervening scales, which are numerous, irregular in size and form, often triangular, and more or less convex; the larger ones vary in diameter from 1 to 2 mm.; the primary plates are about 2 mm. in diameter. The radial shields are divergent

and rather widely separated by a group consisting of two large median and several smaller scales on each side; the radial shields are irregular, polygonal, or somewhat triangular in form, about as long as broad, with the outer end subtruncate or broadly rounded, and the inner end bluntly pointed and strongly divergent. The interbrachial areas beneath are covered with thick imbricated scales, similar to those of the back, and about 15 mm. in breadth.

The mouth shields are pretty regularly shield-shaped, the breadth about equal to the length, the outer margin broadly rounded or subtruncate, the lateral margins nearly straight, and the inner margins convergent to a point and forming sometimes a right angle, but usually an obtuse angle; side mouth-plates narrow, with nearly straight, somewhat divergent edges, with the widest end toward the jaw. Mouth-papillæ numerous and regular, acute conical, seven or eight in number, increasing in length as they approach the end of the jaw.

The genital slits are very long, extending from the mouth-shields to near the underside of the arms; they are bordered externally by a row of short, thin, wedge-shaped, or squarish papillæ, which stand close together in a regular row; those nearest the mouth shields are much the smallest and shortest, and are often nearly square, but in many cases are twice as broad as high; their height usually increases distally to the outer end of the slit, where they are sometimes flat, nearly square, and as long as the arm-spines. In many cases they are more or less soldered together into a continuous series, and in the larger specimen they are often partially wanting.

Innermost tentacle-pore very large, elongated, with about eight regular, flattened, obtuse papillæ on each side; on the next two pairs of tentacle-pores the papillæ are smaller, but nearly as numerous; on the fourth pair there are about four on each side; and on two or three succeeding pairs there are two; beyond that, only a single papilliform tentacle scale. At the base of the arms there are three small, papilliform arm-spines, nearly equal in size, the upper one separated from the two lower ones, which are close together; sometimes three spines appear in the lower group. They are about one-third the length of the side arm-plates; the upper one is often a little larger than the others.

The first under arm-plate is small and pentagonal; the second and third are considerably larger, pentagonal, about as long as broad; the third to the sixth separate the side arm-plates and are transversely elliptical, with an inner angle, broader than long; beyond this the plates gradually become shorter and relatively broader, and the side arm-plates come more and more broadly in contact. The upper arm-plates are strongly convex and prominent, but not much thickened; the three at the base of the arms are short and broad; the fourth is hexagonal, broader than long; beyond this the form becomes regularly hexagonal and the length becomes greater than the breadth, and dis-

tally the outer end becomes rounded and the form somewhat wedge-shape.

Station 2573, off George's Bank, in 1,742 fathoms (No. 12026, U. S. N. M.), 23 specimens, U. S. F. C., 1885.

OPHIOGLYPHA BULLATA, Thomson.

Ophioglypha bullata, WYV. THOMSON, Nature, VIII, p. 400, 1873; Voyage of the Challenger, Atlantic, I, p. 400, fig. 7.—LYMAN, Rep., I Ophiuroidea, Voyage of the Challenger, v, p. 57, pl. 38, figs. 14 to 17, 1882.—VERRILL, Rep. U. S. Com'r Fish and Fisheries, XI, p. 543, 1885.

The large series of specimens of this species taken by the Albatross shows that it is much more variable, especially in respect to the disk-scales, than Mr. Lyman's description indicates. The disk is generally very convex, but sometimes it is nearly flat. The disk-scales and radial scales are usually strongly convex and rough, with small granulations, but sometimes, in specimens from the same lot, they are almost or quite flat and nearly smooth, and in our large examples the large disk-scales and the radial shields are even concave in the middle. Usually the central and five radial primary plates form a regular and prominent rosette of large polygonal scales, without any small ones between them, but in some specimens several small, angular scales are interpolated between the large primary ones in various ways, and the latter are more or less obscured, so as to appear smaller and rounder. In the small specimens, with the disk 4 to 8 mm. in diameter, the six central plates are always conspicuous, thick and convex, and rise above the rest of the disk. There is usually a single, large, inferior, interradial plate, outside the mouth plates, but it is often divided in large specimens. The mouth plates are pretty constant in form. This species was taken at several stations in 1,608 to 2,620 fathoms.

ASTROSCHEMA CLAVIGERA, new species.

Disk small, with prominent radial shields extending to the center; the whole dorsal surface and that of the arms is covered with small smooth granules. Under surface of the arms and sometimes of the disk, nearly destitute of granules. First two tentacle pores without scales: third and sometimes the fourth with one spiniform; those beyond the fifth and sometimes the fourth with two spines, of which the inner becomes large and long, clavate, and rough with spinules distally.

The disk in the type specimen is concave in the middle, with strongly incurved interbrachial spaces, and large, prominent, rounded ribs. Diameter of disk, 8 mm.; breadth of arms at base, 3 mm. The arms are very long, and closely coiled around the branches of a gorgonian. Toward the base they are moderately stout, about as broad as high, then taper gradually to very slender tips; each of the joints is marked by an obtuse, elevated ridge, more or less divided dorsally into two prominences by a longitudinal depression along the median line. The

entire dorsal surface of the disk and arms is closely covered by small rounded granules, which vary but little in size, but those upon the radial shields are a little the largest. The under surface of the disk and arms of one specimen is covered with a smooth skin entirely destitute of granules, but another specimen of the same size from the same locality has the entire under surface of the disk, jaws, and basal part of the arms covered with minute granules, decidedly smaller and more spaced than those on the back; similar granules cover the lower part of the sides of the arms and the intervals between the plates beneath. The teeth are rather large, stout, somewhat spear-head shaped. In one specimen there is a row of three or four small, rounded, subacute mouth-papillæ; but in the other, the sides of the jaws are covered with many small granules like those of the disk.

The genital openings are large and wide, and together form a large pit in the middle of the interbrachial area, in the dry specimen; but in the alcoholic specimen they are large, oblong, rounded at both ends, converging somewhat below, and separated by a granulated depressed area, about twice as wide as their own breadth.

In both specimens the first two pairs of tentacle-pores are destitute of spines or scales; the third pair has but one, rather large spiniform scale; the fourth pair, indifferently one or two, on different arms of the same specimen; the fifth, sixth, and following pairs have two spines, which differ but little in size, but the inner is longer and rapidly increases in size, until it becomes more than twice as long and three or four times as thick as the outer one, on the middle portion of the arm, where a third small, short, spinule sometimes occurs above the two regular ones.

The large inner spine is round and usually somewhat swollen, or club-shaped, with a blunt end; the outer half is thickly covered with minute, sharp, rough spinules. The outer of the two spines is slender, and tapers gradually to a rather sharp point, which is more or less spinulous. Toward the tips of the arms the two spines become very small, slender, acute and nearly equal.

Variations.—The two specimens obtained differ considerably, as mentioned in the above description, in several characters. They are both from the same locality, attached to the same kind of gorgonian, and have the same size, color, and appearance. The most important difference is in the granulation of the under surface of the disk, which is entirely wanting in one specimen and well marked in the other; and in the presence of small mouth-papillæ in the former, which are entirely wanting, or represented only by granules, in the other.

Color in alcohol, salmon brown; the intervals between the arm-plates are darker brown than the plates, and the arm-spines are tipped with dark brown.

Station 2530, off George's Bank, in 956 fathoms (No. 11852, U. S. N.

M.), 2 specimens, clinging to a species of *Paramuricea*. Taken by the U. S. F. C. steamer *Albatross*, 1885.

This species is more nearly allied to *A. intectum*, Lyman, from off Havana, than to any other described species. It differs, however, in the character of the granulation, in the number and arrangement of the proximal tentacle-scales, and in having much larger and clavate spines on the middle portion of the arms.